GEO/07-136
Final

Report of Findings
Raco Army Airfield and
Bomarc Missile Base
Environmental Site Investigation
(Phase III)
Hiawatha National Forest
Raco, Michigan

GEO CONSULTANTS, LLC

contributed to the preparation of this document and should not be considered an eligible contractor for its review.

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CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

GEO Consultants, LLC (GEO) has completed the Final Report of Findings for the Environmental Site Investigation (Phase III) for the Raco Army Airfield and Bomarc Missile Site in Raco, Michigan. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project as defined in GEO's Corporate Quality Control Plan. During the independent technical review, compliance with established policy, principles and procedures, using justified and valid assumptions, was verified. This included review of technical scope, assumptions, technical methods, procedures, and materials used in analyses, appropriateness of data, reasonableness of results, including whether the product meets the customer's needs consistent with the law and existing Corps policy.

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1/10/08

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Significant concerns and the explanation of the resolution are as follows:

None

As noted above, all concerns resulting from the independent technical review of the project have been considered.

1/10/08

Jeff Douthitt, P.E.
President, GEO Consultants, LLC

Date

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ACRONYMS and ABBREVIATIONS

ADR	Automatic Data Review
BCM	BCM Engineers, Planners, Scientists and Laboratory Services
bgs	below ground surface
CCV	continuous calibration verification
CELRL	U.S. Army Corps of Engineers, Louisville District
cpm	counts-per-minute
DO	dissolved oxygen
DoD	U.S. Department of Defense
Earth Tech	Earth Tech, Inc.
EB	equipment blank
EDD	Electronic Data Deliveable
EEI	Envirodyne Engineers, Inc.
EM	Engineering Manual
ESI	Environmental Site Investigation
FS	Forest Service
GC/MS	Gas Chromatograph/Mass Spectrometer
GEO	GEO Consultants, LLC
IDW	Investigation-Derived Waste
IT Corp.	International Technology Corporation
LCS	laboratory control sample
MDEQ	Michigan Department of Environmental Quality
MDL	method detection limit
mmhos/m	millimhos per meter
MS	matrix spike
MSD	matrix spike duplicate
MW	monitoring well
NELAP	National Environmental Laboratory Accreditation Program
NTU	Nephelometric Turbidity Units
ORP	oxidation/reduction potential
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
ppt	parts per thousand
PPE	personal protective equipment
QA	Quality Assurance
QC	Quality Control
QSM	Quality System Manual
Raco AAF	Raco Army Airfield and Bomarc Missile Site
RCDWC	Residential and Commercial I Drinking Water Criteria
RPD	Relative Percent Difference
SAIC	Science Applications International Corporation
SOW	Scope of Work
SVOC	semi-volatile organic compound
TA	TestAmerica Laboratories, Inc.
TB	trip blank
TCE	trichloroethene
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency

UST	underground storage tank
VOA	volatile organic analysis
VOC	volatile organic compound

1. INTRODUCTION

1.1 PROJECT OBJECTIVES

The overall objective of the project as described in this Report of Findings was to perform an Environmental Site Investigation (ESI) at areas of concern at Raco Army Airfield and Bomarc Missile Site (Raco AAF) near Raco, Michigan to support the justification for recommended closure of the site. The location of Raco AAF is illustrated in Figure 1-1 and the areas of concern within the boundary of the site are identified in Figure 1-2 (all figures are provided in Appendix A of this report). Raco AAF currently is owned by the U.S. Department of Agriculture (USDA) Forest Service (FS) and operated by the Hiawatha National Forest. GEO Consultants, LLC (GEO) prepared this Report of Findings under a contract with the U.S. Army Corps of Engineers (USACE), Louisville District (CELRL) Contract No. W912QR-04-D-0030, Delivery Order Number 0013. The primary regulatory agency for overseeing this ESI is the Michigan Department of Environmental Quality (MDEQ) and governed by the National Resources and Protection Act, Part 201 Environmental Regulations.

This report describes the results of tasks performed by GEO at Raco AAF. The tasks included the sampling of groundwater and surface water, a geophysical survey, and a radiological survey. Groundwater samples from eighteen monitoring wells (MWs) located in and around the former fuel depot area and the missile battery area (Figures 1-3 and 1-4, respectively) were collected during two separate field events (June 2007 and August 2007). Samples collected during the June 2007 event were submitted to an analytical laboratory for volatile organic compounds (VOCs) and perchlorate analysis; August 2007 samples were analyzed for VOCs only. The surface water sampling location is located adjacent to the Northeast-Southwest runway and was identified as an area of concern by Hiawatha National Forest personnel (Figure 1-5). After a review of historical facility drawings, the area appeared to be a subsidence associated with a former water treatment facility (Figure 1-6). Photographs of the area are provided in Figure 1-7. Surface water samples were collected during the June 2007 event and analyzed for VOCs, semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals. Samples were submitted to TestAmerica Laboratories Inc. (TA) in St. Louis, MO and TA-Denver (perchlorate) for analysis. TA is a USACE approved laboratory. Analytical summary reports and Electronic Data Deliverables (EDDs) can be found on the CD in Appendix B. A geophysical survey was performed in an area of a suspected former dump area (shown on Figures 1-2 and 6-1) and a radiological survey was performed in the area of confluence of former catch basins (Figure 1-2 and 7-1).

1.2 ORGANIZATION OF REPORT OF FINDINGS

This Report of Findings is organized as follows:

- Section 1 presents that overall project objectives
- Section 2 describes the site physical characteristics as well as results of previous site investigations
- Section 3 describes the approach and results of field investigations
- Section 4 contains a summary of the groundwater investigation
- Section 5 contains a summary of the surface water investigation
- Section 6 contains a summary of the geophysical investigation
- Section 7 contains a summary of the radiological investigation
- Section 8 contains a Quality Assurance Summary Report

- Section 9 presents a list of references that were used to prepare this Report of Findings

Other documents associated with this project include:

- *Quality Control Plan, Raco Army Airfield and Bomarc Missile Site, Environmental Site Investigation (Phase III), Hiawatha National Forest, Raco, Michigan* (GEO 2007a)
- *Sampling and Analysis Plan, Raco Army Airfield and Bomarc Missile Site, Environmental Site Investigation (Phase III), Hiawatha National Forest, Raco, Michigan* (GEO 2007b)
- *Site-Specific Safety and Health Plan, Raco Army Airfield and Bomarc Missile Site, Environmental Site Investigation (Phase III), Hiawatha National Forest, Raco, Michigan* (GEO 2007c)

2. SITE BACKGROUND

2.1 SITE HISTORY

Raco AAF covers approximately one square mile and is located 18 air miles southwest of Sault Ste. Marie, Michigan in the Hiawatha National Forest (Figure 1-1). The U.S. Department of Defense (DoD) used the former Raco site as an airfield for 21 years and as a missile base for about 13 years. The original site layout consisted of a triangular-shaped airfield with 5000 foot runways and 28 missile silos with associated support facilities. The Raco site has been intermittently controlled and used by the DoD and its predecessor agencies since 1895. In 1925, the site was placed under USDA FS management, but was subject to certain reuse rights for defense purposes. The Secretary of Agriculture transferred 240 acres for airfield use by permit dated August 27, 1942. Based on U.S. Geological Survey topographic maps, the airfield covers approximately 640 acres and was constructed between 1942 and 1943. Around 1960, the missile base was constructed on 153.54 acres of land southeast of the airfield. On January 19, 1964, the Air Force released the airfield property to the FS, but retained the acreage covering the missile area. On June 30, 1973, the missile area was released to the FS.

Since 1973, the FS has entered into several permit agreements with outside interests which are summarized below [from *Raco, A Case Study by Carl L. Woodruff, Project Manager, USACE Detroit District and Ronald Pearce, Sault Ste. Marie Area Office, USACE Detroit District*, undated but post 1989 (Case Study)]. An electronic copy of this document is provided in Appendix D.

- 1973 – a sawmill operation by a local Indian Tribe resulting in accumulation of a large pile (approximately 5000 cubic yards) of sawdust, wood waste, and other debris
- 1978 – the sale and removal of seven of the base buildings, the water tower, and 28 missile silo shelters
- 1981 and 1984 – the dumping of broken concrete and waste construction materials into the silos. This debris apparently resulted from road repair operations on Route M-28
- Present – the airfield runways and other portions of the site are currently used during the winter months for automobile tire testing

A description of topography, geology and hydrogeology at Raco AAF follows in Section 2.2; previous investigations are summarized in Section 2.3.

2.2 SITE PHYSICAL CHARACTERISTICS

2.2.1 Site Topography

The topography at the site is relatively flat with elevations ranging from 900 to 920 feet above mean seal level (Figure 2-1).

2.2.2 Site Geology

The geology at the site consists of a series of thick, unconsolidated, glacial deposits of the Quaternary Period. The deposits are composed of sand with traces of gravel and silt. Soil borings completed during a Remedial Investigation performed by International Technology Corporation (IT Corp.) in 1990 and 1991 showed the glacial deposits to be lithologically homogeneous, comprised of fine grained sands, little fines and occasional gravel intermixed with no significant color changes. Depth to bedrock underlying the site has not been established. A 260 foot deep well installed approximately 2.5

miles south of the site in 1994 did not encounter bedrock [Earth Tech, Inc., (Earth Tech) Site Investigation and Associated Activities, Draft Report, 2005 (Earth Tech 2005)].

2.2.3 Site Hydrogeology

Information reported by Earth Tech (2005) provides a useful summary of site hydrogeology conditions at Raco AAF. In general it was noted that the groundwater flow direction trends to the east-southeast, although flow is generally more easterly in the southern portion of the missile battery area. The horizontal hydraulic gradient across the site is approximately 0.002 ft/ft. Slug tests were performed in 1991 by IT Corp. to determine hydraulic conductivity. The data collected using the rising head slug test in MW-05 through MW-15 (excluding MW-08), produced results ranging from 0.0242 cm/sec to 0.23 cm/sec. A literature search conducted in 2002 determined that the hydraulic conductivity of similar sediments in the area was 0.002 cm/sec (from Earth Tech 2005).

2.3 SUMMARY OF PREVIOUS INVESTIGATIONS AT RACO AAF

Following is a summary of previous investigations and studies completed at Raco AAF. All historical documentation included electronically in Appendix D of this report, with the exception of Earth Tech 2005, was provided by MDEQ. All Earth Tech documents were provided by CELRL.

Envirodyne Engineers, Inc. (EEI) conducted a Contamination Evaluation Study between December 1986 and April 1987 for USACE St. Louis District and USACE Huntsville Division. This study included a review of records, site inspection, the installation of four wells (RG-01, RG-02, RG-03, and RG-04), collection of groundwater samples from the four wells, collection of surface water samples from six missile silos, and the collection of near-surface soil samples from nine locations. All collected samples were analyzed for petroleum hydrocarbons, total metals (including barium, cadmium, chromium, lead, arsenic, silver, selenium, and mercury), PCBs, and purgeable halocarbons and aromatics; water samples were also analyzed for dissolved metals (EEI 1987). Drawings depicting all sampling locations, underground storage tank (UST) locations, silo designations, and the missile area transformer pad can be found on Figures 3-1 and 3-2 of EEI 1987. A summary of the findings is presented below. An electronic copy of EEI 1987 is provided in Appendix D.

- All metals concentrations in groundwater samples were found to be below State of Michigan groundwater protection criteria.
- Petroleum hydrocarbons were detected in the sample collected at monitoring well RG-03 at 1.8 mg/L; possible due to the position downgradient of the wastewater treatment plant site and USTs.
- Three volatile organic compounds were also detected in the RG-03 sample: trichloroethene (TCE) at 3.0 µg/L, 2-pentene-3,4,5-trimethyl at 3.4 µg/L, and 1-pentene-2,4,4-trimethyl at 20.8 µg/L.
- Toluene was detected in the groundwater sample collected at RG-04 at 1.9 µg/L, slightly higher than the lower detection limit, but could have been due to the deuterated toluene used in the surrogate spike (Method 8240).
- Low levels of barium and lead were detected in most of the silos. Chromium was detected just above the detection limit in one silo (location not provided). The concentrations of the metals found in the silo water samples were below all applicable drinking water standards.
- Petroleum hydrocarbons were detected in all silos tested at a concentration of 5 mg/L or less in all silos tested with the exception of silo RB-4, which had a concentration of 1810 mg/L.

Silo RB-4 also exhibited signs of organic chemical contamination with benzene and toluene concentrations of 6.0 and 1.2 µg/L, respectively.

- Arsenic, barium, and chromium were detected at low levels and lead was found at 12.4 ng/g (nanogram/gram) in the soil sample from the former wastewater treatment lagoon. It was determined that the lagoon and adjacent denuded area did not appear to be a source of significant metals contamination.
- Comparatively low levels of petroleum hydrocarbons were detected at eight soil sampling locations. A high concentration (8530 µg/L) of petroleum hydrocarbons was found near the transformer pad located south of the former Composite Building. It was concluded that there was no evidence that this soil contamination had affected groundwater concentrations downgradient.
- PCBs were not detected in samples collected at the transformer pad, or in any other soil or water samples.
- There was no evidence that any USTs were leaking petroleum hydrocarbons into the groundwater system.
- Responsibility for the oil spill at the transformer pad was not known.
- Responsibility for potential contamination at well RG-03 was believed to be due to DoD's operation of the wastewater treatment plant at the missile site or possible leakage or spillage at USTs.
- Petroleum hydrocarbon and paint contamination in the silos was not believed to be DoD's as it appeared that the sources of these contaminants were placed there after DoD activities ceased.

Anderson Excavating and Wrecking Company was contracted by USACE Detroit District for a demolition project in 1987. Field activities were substantially completed by November 1988. Details obtained from "Case Study" included:

- Removal of the remaining buildings consisting of two masonry block and structural steel constructions at approximately 26,000 square feet and 6000 square feet of floor area, respectively; and two small masonry block buildings of approximately 190 square feet and 260 square feet of floor area, respectively.
- Removal of 14 USTs and their contents (eight USTs were associated with the Fuel Depot Area and six were associated with the Missile Battery Area).
- Removal of approximately 600 cubic yards of oil soaked soils.
- Removal of asbestos containing materials such as floor tiles, pipe insulation, and boiler room equipment insulation.
- Removal of miscellaneous debris.
- Removal or covering over several exposed building slabs with two feet of earth
- Filling, leveling, and concrete capping of debris in the silos. The silo areas were covered with two feet of earth.
- Fertilizing, seeding, and mulching disturbed and filled areas with a blend of grasses recommended by the FS.

The USTs originally held various petroleum products including gasoline, boiler fuel oil, diesel oil, and aviation gasoline. At the time of removal the tank contents consisted primarily of fuel oil sludges, gasoline, and fuel/water mixtures.

The USTs were removed during July and August, 1988. On removal it was evident that spillage and/or leakage had occurred. Samples taken from the excavations when analyzed showed petroleum hydrocarbon levels as high as 2310 mg/kg (worst case) with the remainder ranging from less than 50 mg/kg to 650 mg/kg.

IT Corp conducted a Remedial Investigation in 1990 (Stage 1) and 1991 (Stage 2) to determine whether past activities at the site had contributed to groundwater and soil contamination and if previous investigations adequately addressed this potential contamination. A Draft version of the 1991 Remedial Investigation Report (IT Corp. 1991) is provided electronically in Appendix D. Figures showing the locations of the USTs, transformer pad, sludge drying bed, and wastewater treatment lagoon associated with the Missile Battery Area are provided in EEI 1987. A figure showing the locations of the USTs associated with the Fuel Depot Area are provided in IT Corp. 1991.

The Stage 1 investigation focused on seven sites: (1) USTs C1/C2, (2) UST C4, (3) UST B1, (4) transformer pad, (5) background boring, (6) sludge drying bed, (7) wastewater treatment lagoon. The scope of work included:

- the installation of eight MWs (MW-05 through MW-12)
- groundwater sampling at 12 MWs (RG-01 through MW-12)
- slug testing of MW-05 through MW-12
- advancement, sampling, and analysis (51 samples) of eight soil borings (USTs C1, C2, C4, and B1, transformer pad, sludge drying bed, wastewater treatment lagoon, background location)
- collection of 16 geotechnical samples
- a geophysical survey of a potential landfill area

The Stage 2 investigation focused on five sites: (1) transformer pad, (2) background boring, (3) sludge drying bed, (4) wastewater treatment lagoon, and (5) fuel depot area. The scope of work included:

- the installation of three MWs (MW-13 through MW-15)
- groundwater sampling at six MWs (RG-01, RG-03, MW-08, MW-13, MW-14, MW-15)
- slug testing of MW-13, MW-14, and MW-15
- advancement, sampling, and analysis (44 samples) of seven soil borings (transformer pad, background boring, downgradient of sludge drying bed, wastewater treatment lagoon, fuel depot area)
- collection of 19 geotechnical samples.

Out of the total nine areas or sites of investigations, only three, UST C1/C2, the sludge drying bed, and the wastewater treatment lagoon were carried into a Baseline Risk Assessment and were deemed to have potential future concerns.

- At depth, soils of the sludge drying bed contained levels of chromium and lead that were above established state and site background levels. In the monitoring well (MW-14) located

downgradient of the site, lead was again detected at concentrations (9.5 µg/L in primary sample and 11 µg/L in duplicate) above the type B cleanup criteria established by the State.

- At depth, soils of the wastewater treatment lagoon contained levels of chromium that were above established state and site background levels. Pentachlorophenol (PCP) was also detected in the soil boring. At the time of this investigation, there was no established cleanup level for PCP by the State of Michigan. PCP was not detected in groundwater.
- Soil at UST C1/C2 also contained levels of PCP. PCP was not detected in groundwater.
- All other compounds detected at other sites in groundwater and soil were eliminated as potential contaminants of concern using Michigan Act 307's type A, B, and C criteria.

BCM Engineers, Planners, Scientists and Laboratory Services (BCM) conducted a soil probe investigation of the site focusing on the areas around the former UST locations in 1996. This investigation included 113 soil borings and 200 soil samples taken from in and around the former UST locations. Available portions of this report, including boring logs are provided electronically in Appendix D. Former UST locations are provided in EEI 1987 (electronically in Appendix D of this report).

Sverdrup Environmental, Inc conducted a supplemental remedial investigation at the site in 1996 and 1997. This investigation included installation of soil borings and sampling of existing monitoring wells. Elevated concentrations of lead were found during the 1996 groundwater sampling of the monitoring wells. As a result, the monitoring wells were redeveloped and sampled in 1997. Elevated lead was not detected in the 1997 round of sampling. The 1996 report was edited to include the 1997 data. The above information is adapted from Earth Tech 2005.

Barr Engineering completed a review of all information pertaining to the site in 2002. The review was done on behalf of the USDA FS to address complaints that had been made by local organizations (identification of specific organizations not provided) which believed that during demolition certain materials were buried or spilled. It is unclear from the information provided in Earth Tech 2005 if the referenced demolition was that performed by Anderson Excavating and Wrecking Company. The investigation revealed that documentation exists showing that the materials which were of concern (hydrocarbon waste, asbestos, and PCBs) were in fact properly dealt with on site or removed and disposed. The report further recommends investigating the claims of improper disposal would help to refute or verify any concerns of possible debris being buried in those specific areas. The Barr Engineering report addressed the sufficiency of the previous investigations and suggested that the subsurface contamination had been properly delineated, both vertically and laterally. It also indicated that there were data gaps in the groundwater data. The above information is adapted from Earth Tech 2005.

Earth Tech conducted a Site Investigation at the site in phases from September 2003 to November 2004. The 2003 investigation was designed to address the aforementioned citizen concerns regarding improper disposal practices that may have occurred at the site, and to evaluate the site for potential closure. The 2004 investigation was designed to evaluate the extent of TCE contamination in the Missile Battery Area. This investigation included the installation of soil borings, redevelopment of existing wells, a geophysics survey of the former borrow pit area, the installation and development of new wells, and groundwater sampling. The following information and data was compiled from Earth Tech 2005.

2003 Activities

- An electromagnetic survey was conducted and two soil borings were drilled in the borrow pit areas and three soil borings were drilled in the Missile Battery Area to address the prior concerns regarding improper dumping during the demolition project. All borings were advanced to a depth of 50 feet below ground surface (bgs) or groundwater, whichever was

encountered first. Soil samples were collected in two-foot intervals on 10-foot centers. Results of the investigation did not indicate the presence of contamination.

- Three additional monitoring wells [MW-16 (Fuel Depot Area), MW-17 (associated with location of former UST B1), MW-18 (associated with location of former USTs C2 and C3)] were installed and sampled to address data gaps. No chemicals were detected above the MDEQ Part 201 screening levels. However, TCE was detected in MW-18 at 1.6 µg/L.
- All existing MWs were redeveloped and re-sampled due to previous sampling events indicating a potential lead problem believed to be a result of the conditions of the wells.
- All analytical results for lead were below MDEQ Part 201 criteria. Carbon disulfide was detected in five of the wells in concentrations ranging from 2.7 µg/L in RG-04 to 18 µg/L in MW-08. TCE was detected in MW-18 at 1.6 µg/L and MW-08 at 14 µg/L. The detection of TCE in MW-08 was above the MDEQ Part 201 Residential and Commercial I Drinking Water Criteria (RCDWC) of 5 µg/L. No SVOCs were detected in any samples collected. Metals that were observed in the non-filtered samples included: aluminum, barium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, sodium, thallium, vanadium, and zinc. Of those analytes, only aluminum (non-filtered) detected in MW-08 at 454 µg/L (50 µg/L) and iron (non-filtered) detected in MW-05 at 1440 µg/L (300 µg/L) exceeded MDEQ Part 201 RCDWC.

2004 Activities

- Groundwater samples were collected from the same wells sampled during the October 2003 event. TCE was detected in MW-18 and MW-08 at 0.56 µg/L and 19 µg/L, respectively, and chloromethane was detected in RG-02. The detection of TCE in MW-08 was above the MDEQ Part 201 RCDWC of 5 µg/L. No SVOCs were detected in any samples collected. Metals that were observed in the analytical results included: aluminum, antimony, arsenic, barium, beryllium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, sodium, thallium, zinc, and mercury. Of those, only aluminum (non-filtered) detected in MW-09 at 62.9 µg/L exceeded MDEQ Part 201 RCDWC level of 50 µg/L.
- Five soil borings were advanced to a depth of 80 feet bgs in the Missile Battery Area, specifically the former Composite Building, sludge drying bed, and wastewater treatment plant lagoon, to investigate those areas deemed most likely to be a source of TCE contamination detected in the groundwater and to determine the optimum placement for additional wells. Soil samples were collected at 10, 20, and 40 feet bgs; groundwater samples were collected at 70 and 80 feet bgs. The soil samples indicated no evidence of a source area for the TCE. The groundwater data, however, indicated low concentrations of TCE in four of the borings.
- Based on the results of the soil boring investigations, four new wells (MW-19, MW-20, MW-21, and MW-22) were installed to depths of approximately 90 feet bgs.
- MW-07, MW-08, MW-14, and MW-18 were sampled for VOCs. MW-19, MW-20, MW-21, and MW-22 were sampled for VOCs, SVOCs, and metals. TCE was detected in MW-08 (19 µg/L), MW-18 (0.8 µg/L), MW-19 (4.4 µg/L), and MW-20 (0.52 µg/L). 1,1,1-trichloroethane was detected in MW-19 (0.46 µg/L), MW-20 (0.74 µg/L), and MW-22 (0.32 µg/L). Chloromethane was detected in MW-21 at 0.96 µg/L. Tetrachloroethylene was detected in MW-19 (0.44 µg/L), MW-20 (0.54 µg/L), and MW-22 (0.69 µg/L). Toluene was detected in MW-19 (0.79 µg/L), MW-20 (0.4 µg/L), and MW-21 (0.44 µg/L). Of these only TCE detected in MW-08 exceeded the MDEQ Part 201 RCDWC level of 5 µg/L. No SVOCs were detected in any samples collected. Metals that were observed included arsenic,

barium, cadmium, chromium, lead, and selenium. Of those, only lead detected in the non-filtered samples from MW-20 (9 µg/L), MW-21 (8.8 µg/L), and MW-22 (94.8 µg/L) exceeded the MDEQ Part 201 RCDWC level of 4 µg/L; all filtered samples were below MDEQ Part 201 criteria. Lead concentrations in the redeveloped wells were below MDEQ Part 201 criteria.

TCE had been detected in MW-08 six times during the nine sampling events for which historical data are available: September 1990 (3 µg/L), July 1991 (3 µg/L), 2002 (11 µg/L), October 2003 (14 µg/L), May 2004 (19 µg/L) and November 2004 (19 µg/L) (Earth Tech 2005).

3. FIELD INVESTIGATION

This section describes the field procedures used during the Raco AAF ESI. Field activities included in the ESI are summarized in Section 3.1. Sections 3.2 through 3.9 contain procedures for the field activities. Specifically, these are:

- groundwater sampling at monitoring wells (Section 3.2)
- surface water sampling at subsidence area (Section 3.3)
- water level measurements in groundwater monitoring wells (Section 3.4)
- geophysical survey (Section 3.5)
- radiological survey (Section 3.6)
- decontamination of drilling equipment and tools (Section 3.7)
- management of Investigation-Derived Waste (IDW) (Section 3.8)

3.1 ESI FIELD ACTIVITIES AT RACO AAF

A summary of previous field investigations was presented in Section 2.3. The following sections detail the approach implemented by GEO for completion of the assigned tasks.

3.1.1 Groundwater sampling

Existing wells within the Fuel Depot and Missile Battery areas (see Figures 1-3 and 1-4) were sampled for VOCs and perchlorate. The field activities are as follows:

- Two rounds of groundwater samples (June and August 2007) were collected using low-flow sampling techniques in accordance with MDEQ sampling guidelines at 18 existing monitoring well locations across the site (see Table 3-1 and Figures 1-3 and 1-4 for locations). The intent of groundwater sampling was to verify historical results and obtain new data necessary to support a basis for closure of the site for unrestricted use. Samples were submitted to a USACE approved laboratory for analysis (Table 3-2). Section 3.2 describes the groundwater sampling procedure that was used. Samples collected during the June 2007 event were analyzed for perchlorate and VOCs. Samples collected during the August 2007 event were analyzed only for VOCs. A complete list of constituents included in the VOC suite is provided in Table 3-3.
- VOCs were analyzed by TA-St. Louis using U.S. Environmental Protection Agency (USEPA) Method 8260B in accordance with SW-846, Third Edition, Update 1, Revision 1 (1990) and the Department of Defense Quality Systems Manual (QSM) for Environmental Laboratories, Version 3, January 2006.
- Perchlorate was analyzed by TA-Denver using USEPA Method 6860 following Standard Operating Procedures recommended in the DoD Perchlorate Handbook, March 2006.
- Water levels were measured in all wells designated for sampling during the June 2007 event to construct a "snap-shot" of the potentiometric surface (Figure 3-1) prior to installing dedicated bladder pumps. See Section 3.4 for water level measurement methods. Due to some water levels being below the top of the pumps during the August 2007 event, not all wells sampled during that event are included in the potentiometric surface mapping (Figure 3-2).
- Field parameters were measured during purging prior to the collection of groundwater samples and included pH, dissolved oxygen (DO), specific conductance, turbidity, and

oxidation/reduction potential (ORP). Due to the lack of available water and slow recharge rates in a number of wells, only one set of field parameters were obtained without stabilization prior to sampling. Methods for field measurements and groundwater sampling are presented in Section 3.2.

3.1.2 Surface water sampling

During an earlier field visit by Hiawatha National Forest personnel, a subsidence area was identified adjacent to the Northeast – Southwest runway. Based on a historical drawing titled "*Former Air Force & Missile Site, Raco, Michigan, Demolition of Structures, Detailed Site Demolition Plan, July 1987*", this area appeared to be associated with a former "Waste Water Treatment System" (see Figures 1-5 and 1-6). The subsidence was measured as having a depth of approximately 10 feet bgs and contained approximately one foot of water (see Figure 1-7 for photographs). Upon a close visual examination of the area, the subsidence was determined to be the result of a collapse of overburden material into an existing horizontal drainage tile approximately 15 inches in diameter. At the request of the Hiawatha National Forest, a grab sample of surface water in the subsidence was collected during the June 2007 sampling event and submitted to TA-St. Louis for VOC (Method 8260B), SVOC (Method 8270C), metals (Methods 6010B/7470A), pesticides/PCBs (Methods 8081A/9082) analysis. This subsidence area was subsequently filled in September 2007 by placing large stone (8 to 12 inch diameter) into the bottom of subsidence, followed by smaller gravel, then capping with native soil.

The scope of the groundwater and surface water sampling at Raco AAF is summarized in Tables 3-1, 3-2, 3-3, and 3-4. Detailed procedures for field sampling activities are presented in Sections 3.2 and 3.3.

Table 3-1. Monitoring wells sampled during the 2007 sampling events.

Monitoring well - location	
MW-11 – Fuel Depot Area	MW-08– Missile Battery Area
MW-16 – Fuel Depot Area	MW-14 – Missile Battery Area
MW-09 – Southeastern runway area	MW-15 – Missile Battery Area
MW-10 – Central runway area	MW-17 – Missile Battery Area
MW-12 – Western runway area	MW-18 – Missile Battery Area
RG-02 – Missile Battery Area	MW-19 – Missile Battery Area
MW-05 – Missile Battery Area	MW-20 – Missile Battery Area
MW-06 – Missile Battery Area	MW-21 – Missile Battery Area
MW-07 – Missile Battery Area	MW-22 – Missile Battery Area

Table 3-2. Summary of groundwater sample collection and analyses at Raco AAF.

Groundwater Sampling Procedure	Analytes/Method		Number of Quality Control Field Samples[a]	
	First Round (June 2007)	Number of Field Samples	Field Duplicate	Matrix Spike/Matrix Spike Duplicate
Low-flow/micropurge or minimum/no purge sampling from monitoring wells	VOCs/8260B	18	2	1/1
	Perchlorate/6860	18	2	1/1
	Second Round (August 2007)			
Low-flow/micropurge or minimum/no purge sampling from monitoring wells	VOCs/8260B	18	2	1/1

[a] Equipment blanks and trip blanks not included in this table. See Section 3.9 for more detail regarding field QC samples, including trip and equipment blanks.
Note: Specific analytes included for analysis with associated reporting limits can be found in Table 3-4.
Note: The Scope of Work (SOW) indicates that no Quality Assurance samples were needed.

Table 3-3. Summary of surface water sample collection and analyses at Raco AAF.

Surface Water Sampling Procedure	Analytes/Method		Number of QC Field Samples
	First Round (June 2007)	Number of Field Samples	Field Duplicate
Grab sample	VOCs/8260B	1	1
	SVOC/8270C	1	1
	Metals[1]/6010B/7470A	1	1
	Pesticides/PCBs/8081A/8082	1	1

[1] Metals, unfiltered, include: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, mercury.

Table 3-4. Project specific reporting limits and method detection limits.

Analyte	Method Reporting Limits (µg/L)	Method Detection Limits (µg/L)	Analyte	Method Reporting Limits (µg/L)	Method Detection Limits (µg/L)
Perchlorate	0.1	0.0088	Chlorobenzene	1	0.027
VOCs			Chloroethane	2	0.05
1,1,1-Trichloroethane	1	0.035	Chloroform	1	0.048
1,1,2,2-Tetrachloroethane	1	0.144	Chloromethane	2	0.048
1,1,2-Trichloroethane	1	0.092	*cis*-1,2-dichloroethene	1	0.048
1,1-Dichloroethane	1	0.046	*cis*-1,3-dichloropropene	1	0.05
1,1-Dichloroethene	1	0.045	Dibromochloromethane	1	0.111
1,2,4-Trichlorobenzene	1	0.091	Dichlorodifluoromethane	2	0.045
1,2-Dibromo-3-chloropropane	1	0.554	Ethylbenzene	1	0.064
1,2-Dichlorobenzene	1	0.064	Isopropylbenzene	1	0.027
1,2-Dichloroethane	1	0.106	Methylene Chloride	1	0.601
1,2-Dichloropropane	1	0.077	M-Xylene	2	0.054
1,3-Dichlorobenzene	1	0.036	O-Xylene	1	0.031
1,4-Dichlorobenzene	1	0.047	P-Xylene	2	0.054
2-Butanone	5	1.81	Styrene	1	0.044
2-Hexanone	5	1.03	Tetrachloroethene	1	0.171
4-Methyl-2-pentanone	5	0.206	Toluene	1	0.025
Acetone	2	0.8	*trans*-1,2-dichloroethene	2	0.016
Benzene	1	0.064	*trans*-1,3-dichloropropene	1	0.085
Bromodichloromethane	1	0.064	Trichloroethene	1	0.037
Bromoform	1	0.118	Trichlorofluoromethane	1	0.032
Bromomethane	2	0.085	Vinyl Chloride	2	0.044
Carbon Disulfide	1	0.031	Xylene (total)	3	0.126
Carbon Tetrachloride	1	0.039			

Note: M-xylene and P-xylene co-elute and therefore cannot be distinguished from each other. These are reported as M-xylene & P-xylene with a single value for both isomers.

Table 3-4. Project specific reporting limits and method detection limits (continued).

Analyte	Method Reporting Limits (µg/L)	Method Detection Limits (µg/L)	Analyte	Method Reporting Limits (µg/L)	Method Detection Limits (µg/L)
SVOCs			**Metals**		
Acenapthene	10	1.0	Aluminum	200	54.33
Anthracene	10	1.136	Antimony	10	4.664
Benzo(a)anthracene	10	1.0	Arsenic	10	1.917
Benzo(a)pyrene	10	1.0	Barium	50	5.0
Benzo(b)fluoranthracene	10	1.0	Beryllium	5	0.5718
Benzo(g,h,i)perylene	10	1.0	Cadmium	5	0.1775
Benzo(k)fluoranthene	10	1.0	Calcium	2500	18.045
Bis(2-ethylhexyl)pthalate	10	1.0	Chromium	10	2.466
Butyl benzylpthalate	10	1.0	Cobalt	50	5.0
Chrysene	10	1.0	Copper	25	1.845
Di-n-butylpthalate	10	1.0	Iron	100	18.61
Diethylpthalate	10	1.0	Lead	10	1.923
Fluoranthene	10	1.0	Magnesium	1000	108.2
Pentachlorophenol	50	2.0	Manganese	15	2.458
Phenanthrene	10	1.0	Nickel	40	4.564
Pyrene	10	1.0	Potassium	5000	1633
Pesticides/PCBs			Selenium	15	3.712
Chlordane (technical)	0.5	0.0989	Silver	10	1.679
Endrin	0.05	0.0068	Sodium	1000	78.53
Gamma-Chlordane	0.05	0.0088	Thallium	20	5.188
Heptachlor	0.1	0.0336	Vanadium	50	6.062
Heptachlor epoxide	0.05	0.0062	Zinc	20	3.279
Methoxychlor	0.1	0.01	Mercury	0.3	0.0927
Toxaphene	2.0	0.5901			
PCBs	1.0	0.44/0.30			

3.1.3 Geophysical survey

At the request of MDEQ, a geophysical survey was conducted in an attempt to detect and identify the footprint of any buried metallic debris in an area presumed to be an old dump site located southeast of the base. The dump site potentially was used by the U.S. Air Force when the base was in operation. The site in question is approximately 11,000 square feet in area and its location is identified in Figures 1-2 and 6-1. All methods and procedures were consistent with Engineering Manual (EM) 1110-1-1802, *Geophysical Exploration for Engineering and Environmental Investigations*, August 1995. Procedures for the geophysical survey field activities are presented in Section 3.5.

3.1.4 Radiological survey

While conducting an earlier field reconnaissance at the Raco AAF, MDEQ identified one area near the confluence of the former catch basins (along the north end of the Missile Battery Area) where

radioactivity exceeding the natural background level was measured using a Ludlum Model 193-6 survey meter. The location of the confluence of the catch basins as well as "test holes" advanced as part of this investigation are depicted on Figures 1-2 and 7-1. The typical background reading at the site for the Ludlum survey meter was about 6 micro-Roentgens per hour (µR/hr). The MDEQ identified one area where the ground had slumped, leading to a hole. The survey meter was placed into the hole, and the readings increased to about 25 µR/hr. MDEQ requested that a radiological survey be completed in the area of two former catch basins within the Missile Battery Area to resolve this anomalous reading.

A radiological survey of the former catch basins area was conducted by a health physics technician, following the guidance provided in Section 5.2 of Multi Agency Radiological Site and Survey Investigation Manual (MARSSIM), NUREG-1575, USEPA Document No. 402-R-97-016, latest edition. The results of the survey were compared to expected typical background readings for the site. Measurements of radioactivity in excess of what natural background levels were judged as due to the sampling geometry. Procedures for the radiological survey field activities are presented in Section 3.6.

3.2 GROUNDWATER SAMPLING FROM MONITORING WELLS

Prior to installing pumps and sampling, the static water level and depth to bottom of each well was measured and recorded in the field log book. Dedicated polyvinyl chloride bladder pumps with Teflon bladders, manufactured by QED, and fitted with 3/8" Teflon-lined polyethylene tubing were installed in each well on June 4, 2007. Pump placement was determined after the water level and total well depth were determined. In the event that the water level was determined to be below the top of the screen, the pumps were placed approximately 0.5 feet above the bottom of the well; all other pumps were placed approximately 3 feet above the bottom of the well where a sufficient water column existed. Water levels and total depths can be found in Table 3-5. Upon completion of the sampling events, the pumps were left in the wells.

Standard water quality field parameters (i.e., temperature, pH, specific conductance) were monitored utilizing a Hydrolab® Quanta water quality meter calibrated to the manufacturer's guidelines and results were recorded during purging at three-minute intervals until stable values were obtained. For wells determined to have water levels below the top of the pump and which also demonstrated slow recharge times, a minimum/no purge procedure was implemented where only one set of water quality parameters were obtained to prevent purging the well dry. Parameters were considered stable when variations in temperature, pH, and specific conductance did not exceed ± 0.5°C, ± 0.1 SU, or ± 0.3%, respectively, for three consecutive readings. Water quality parameters recorded during both sampling events can be found in Appendix C. After parameter stabilization, the natural attenuation field parameters (pH, DO, ORP) as well as temperature, specific conductance, and turbidity were recorded. The Hydrolab® was equipped with a flow-through cell, and included pH, DO, ORP, temperature, specific conductance, and turbidity probes. The specifications on the probes are as follows:

- pH: Range: 0 to 14 pH units; Accuracy: ± 0.2 units; Resolution: 0.01 units.
- DO: Range: 0 to 50 mg/L; Accuracy: ± 0.2 mg/L for 20mg/L; Resolution: 0.01 mg/L.
- ORP: Range: -999 to 999 mV; Accuracy: ± 20 mV; Resolution: 1 mV.
- Temperature: Range: -5ºC to 50ºC; Accuracy: ± 0.2ºC; Resolution: 0.01ºC.
- Specific conductance: Range: 0 to 100 mS/cm; Accuracy: ± 1% of reading ± 1 count; Resolution 4 digits.
- Turbidity: Range: 0 to 1000 Nephelometric Turbidity Units (NTU); Accuracy: ± 5% of reading ± 1 NTU; Resolution: 0.1 NTU < 100 NTU/1 NTU ≥ 100 NTU.

Table 3-5. Monitoring well depths and water levels.

Well Number	Total Depth[1,2] (feet)	Top of Casing Elevation[3] (feet)	Static Water Level and Elevation (feet) June 2007		August 2007		UTM 16N NAD 83[4] Easting	Northing
MW-11	45.58	911.94	41.30	870.64	40.67	871.27	666774.825	5135642.695
MW-16	44.42	907.81	38.80	869.01	38.44	869.37	666745.602	5135478.755
MW-09	47.33	903.28	43.02	860.26	NA	NA	668379.221	5134984.595
MW-10	44.82	903.98	41.92	862.06	NA	NA	668312.333	5135646.943
MW-12	43.13	906.80	39.36	867.44	38.90	867.90	667368.620	5135668.035
RG-02	52.70	906.06	49.88	856.18	NA	NA	668940.831	5134818.194
MW-05	63.60	915.47	58.53	856.94	NA	NA	668860.922	5135327.742
MW-06	59.10	909.24	52.59	856.65	52.22	857.02	668847.653	5135121.653
MW-07	59.01	907.02	50.95	856.07	50.56	856.46	668902.160	5135123.112
MW-08	75.65	905.75	49.58	856.17	49.92	855.83	669007.348	5135111.988
MW-14	58.87	909.81	54.54	855.27	54.21	855.60	669020.417	5135187.024
MW-15	57.23	907.16	50.61	856.55	50.16	857.00	668853.094	5135105.369
MW-17	56.97	906.05	49.91	856.14	49.60	856.45	668893.817	5135279.938
MW-18	59.02	908.10	52.46	855.64	51.92	856.18	668951.180	5135072.186
MW-19	93.93	907.61	52.43	855.18	52.09	855.52	669019.534	5135137.679
MW-20	89.00	909.81	54.72	855.09	54.38	855.43	669036.061	5135101.965
MW-21	93.95	905.57	50.46	855.11	50.12	855.45	669000.986	5135181.970
MW-22	91.63	907.68	52.12	855.56	51.70	855.98	668955.755	5135073.772

[1]Total Depth measured on June 4, 2007
[2]All depths measured from top of casing
[3]Top of Casing Elevation data from Earth Tech 2005
[4]Easting and Nothing data obtained during and differentially corrected after the August sampling event
NA = Water level below top of pump

3.3 SURFACE WATER SAMPLING FROM SUBSIDENCE AREA

Prior to sampling the water present in the subsidence, the dimensions (total depth and width) and the depth to water were measured and recorded in the field logbook. A grab sample was collected with the use of a pre-cleaned polyethylene dipper. Specific sample containers were then filled on an individual basis. Standard water quality field parameters (i.e.; temperature, pH, specific conductance) were measured and recorded in the field logbook. Measurements are available in Appendix C of this report.

3.4 WATER LEVEL MEASUREMENTS IN GROUNDWATER MONITORING WELLS

Static water level and depth-to-bottom measurements were measured on July 4, 2007 to the nearest 0.01 foot in all wells at Raco AAF included in the scope of this investigation. Static water levels were also measured on August 7, 2007. Due to static water levels being below the top of the pump for RG-02, MW-05, MW-09, and MW-10 during the August event, no data were obtained. Potentiometric surface maps are provided as Figures 3-1 and 3-2 in Appendix A.

3.5 GEOPHYSICAL SURVEY AT THE FORMER DUMP SITE

A geophysical survey of the location identified by MDEQ as a former dump area was conducted using an EM-31 electromagnetic transmitter. The objective of the survey was to map variations in the electromagnetic environment of the subsurface in an attempt to determine if metallic debris exists below

the ground surface and to identify the footprint of disturbed soils that define the dump area. The area was sectioned off by a series of parallel survey lines located ten feet apart. Data was collected along each survey line. Instrument readings were obtained to determine the extent of the landfill. Based on results of the field survey, it was determined that no buried materials existed. However, due to the sandy nature of the soils in the area, no discernible features could be identified detailing the boundaries of the "disturbed" area. Drawings showing conductivity and metal detection data are provided as Figures 6-2 and 6-3, respectively, in Appendix A. A complete summary of this investigation is presented in Section 6 of this report.

3.6 RADIOLOGICAL SURVEY AT THE CONFLUENCE OF CATCH BASINS

Under the direction of Mr. Matt Baltusis with MDEQ, a radiological survey was performed in and around the location of the catch basin confluence where radiation levels above background were identified during an earlier site visit by MDEQ (Figure 1-2 and 7-1). The planned radiological scoping survey approach is described in Section 3.3 of the "Sampling and Analysis Plan" (GEO 2007b) for the Phase III Environmental Site Investigation.

The primary radiological instrument used in the radiological survey was a highly sensitive 2" x 2" sodium iodide (NaI) gamma radiation detector, coupled with a count-rate meter. This instrument is used extensively in environmental investigations to search for the presence of radioactive materials or sources of radiation on structures and in surface soils. The instrument is sensitive enough that it often can be used to demonstrate that soils are acceptable for unrestricted release, depending on the radionuclides present and the local site conditions. The typical background count rate is about 8000 to 12,000 counts-per-minute.

The catch basin and immediate area were scanned and compared to two additional locations following the same procedure. All locations presented comparable background levels as well as showing an increase in count rates when the instrument was positioned below ground surface. The results implied that the increase in the count rate was a direct result of the environment geometry and not the presence of radioactive materials. A complete summary of this investigation is presented in Section 7 of this report.

3.7 DECONTAMINATION OF SAMPLING TOOLS

Due to the use of dedicated sampling equipment, decontamination was not required for this task.

3.8 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

IDW generated during this sampling event consisted of purge water and personal protective equipment (PPE). During sampling all IDW was stored in plastic bags (PPE) or carboys (purge water). Upon completion of each sampling event, purge water was poured onto sections of the concrete runways with no noticeable cracking and allowed to evaporate. PPE was disposed of as "non-hazardous" material after a review of analytical data.

3.9 FIELD QUALITY CONTROL PROCEDURES AND DOCUMENTATION

3.9.1 Field Instrument Calibration and Maintenance

The GEO Project Manager was responsible for ensuring that instrumentation for DO, pH, and ORP are of the proper range, type and accuracy for the test being performed. Water quality instruments were calibrated prior to use before both sampling events. Radiological instruments were calibrated prior to use and received a daily quality control check while in-use. Copies of calibration sheets can be found in Appendix C.

3.9.2 Field Quality Control (QC) Samples

An **equipment blank (EB)** was collected by pouring deionized water over one of the bladder pumps prior to installation. Preservation and analysis (VOCs) of field EBs was identical to that of the associated environmental samples.

Trip blanks (TBs) serve to detect possible cross-contamination of samples resulting from handling, storage and shipment procedures. Due to an oversight by the analytical laboratory, no TBs were provided or included with the June 2007 sampling event. TBs were included with the August 2007 event.

A **temperature blank** was sent with each cooler of samples to verify that the cooler temperature had been maintained at 4°C.

Field duplicate samples were collected at a rate of one duplicate for up to every 10 environmental samples of the same matrix (see Table 3-2). The duplicate samples were collected from the same location and at the same time as the original environmental sample; however, the duplicate samples were "coded" with a unique sample identifier in such a manner that the laboratory is not able to determine the original field sample (i.e., "blind" duplicates). An explanation of the duplicate "coding" is provided in Section 3.7.3 of GEO 2007b, and duplicate samples were noted in the field logbook.

Matrix spike (MS)/matrix spike duplicates (MSD). Groundwater MS/MSD sample pairs were collected from one monitoring well during both sampling events.

Split Samples were not required for this task.

3.9.3 Field Logbooks

Documentation in field logbooks is an important record for reconstructing field and sample handling activities. Copies of the field logbook pages are included in Appendix C of this report. All field logbooks are bound with consecutively numbered pages.

3.9.4 Field Performance Audits

GEO ensured quality in the field work by following the USACE three-phase control process (Section 3.3.4. of USACE EM-200-1-3), where the three phases consist of the preparatory phase, initial phase, and follow-up phase as detailed in Section 3.6.4 of GEO (2007b).

The June 2007 events (i.e., groundwater sampling, geophysical survey, radiological survey) were performed in the presence of MDEQ and FS personnel. No deficiencies were brought to the attention of GEO at the time of or following completion of the June 2007 field activities.

3.9.5 Corrective Actions

No deviations from the specified procedures within approved project plans were necessary and did not warrant corrective actions.

3.9.6 Changes in the Field Program

During the field investigation, no changes to the survey and/or sampling program were necessary.

3.10 SAMPLE CUSTODY, HANDLING, AND HOLDING TIMES

Table 3-6 summarizes the sample containerization, preservation and holding times for groundwater samples collected during the Raco AAF ESI. More detail regarding sample handling is provided below.

3.10.1 Documentation of Custody

Chain-of-custody forms were completed following requirements in *Appendix F, Sample Documentation and Shipment Instructions* of USACE EM 200-1-3 (USACE 2001). Chain-of-custody forms are provided with the analytical data summary reports presented in Appendix B of this report.

3.10.2 Sample Labeling and Numbering

Sample labeling and numbering procedures were consistent with labeling practices provided in Sections 3.7.2 and 3.7.3 of GEO 2007b.

3.10.3 Holding Times and Turnaround Time

Each analytical method has a specified holding time for the field samples (see Table 3-5 as defined in the specific method procedure). The laboratory successfully analyzed all samples within the maximum holding times as provided by the specific method except for the August sampling of MW-20 where the pH of the presumably preserved sample was >2. This well, however, was not contaminated in June and showed only a J-coded result for TCE in August.

Table 3-6. Sample containers, preservation and holding times.

Sample Medium	Analytes/Method	Container	Preservation	Holding Time
Groundwater	Perchlorate/6860	2 x 125-mL polyethylene	Cooled to 4° C	28 days
Groundwater Surface water	VOCs/8260B	2 x 40-mL VOA vial, Teflon septa cap	Cooled to 4° C, HCl, pH<2	14 days
Surface water	SVOCs/8270C	2 x 1L AG	Cooled to 4° C	40 days
Surface water	Metals/6010B/7470A	2 x 1L P,G	Cooled to 4° C, HNO_3, pH<2	180 days 28 days
Surface water	Pesticides/PCBs/8081A/8082	2 x 1L P,G	Cooled to 4° C	40 days

VOA: Volatile organic analysis vial
AG = Amber Glass
P,G – HDPE or Glass

4. GROUNDWATER INVESTIGATION

4.1 SUMMARY OF GROUNDWATER INVESTIGATION

VOCs (June 2007 data): Wells MW-08 and MW-19, anticipated to yield contaminated groundwater, had TCE (MW-19 at 32 µg/L in a single sampling and MW-08 at 18 µg/L and 19 µg/L in both samplings). Traces of TCE were reported from MW-18 (0.82J µg/L) and RG-02 (0.62J µg/L). Both of the latter results are unreliable being J-coded. TCE had been reported previously in MW-18 (see Section 2) at trace levels. The result for MW-19, however, is higher than previously reported (see Section 2) and now exceeds the MDEQ requirement of 5 µg/L

Chloromethane (J-coded) was reported in two wells: MW-06 (0.13J µg/L) and MW-10 (0.125J µg/L). A trace of acetone (4.3 µg/L) was also reported in MW-10 but this well was sampled in duplicate and the other sample contained <2 µg/L. Note that chloromethane has been reported previously, but for different wells (see Section 2).

1,1,1-trichloroethane (J-coded) was reported in MW-19 (0.2J µg/L). Traces of this analyte (0.46 µg/L) were reported in this well previously (see Section 2).

VOCs (August 2007 data): The expected contaminated wells were sampled in duplicate and both had TCE results similar to previous samplings (MW-19 at 33 µg/L and 32 µg/L in two samplings and MW-08 at 12 µg/L in both samplings). Both wells exceeded the MDEQ requirement of 5 µg/L. TCE also was reported in MW-18 at 0.6J µg/L and in MW-20 at 0.42J µg/L. The report for MW-18 was consistent with the June 2007 data lending credibility to there being trace levels in this well. MW-20, however, was not contaminated during the June round of sampling and RG-02, which reportedly contained a trace of TCE in June, had no TCE reported in August.

Chloromethane (J-coded) was reported in the following wells: MW-05, MW-08, MW-09, MW-10, MW-11, MW-15, MW-16, and MW-20; and also in the trip blank accompanying the samples. The highest concentration reported was 0.75J µg/L. Considering that the method detection limit (MDL) for chloromethane is 2.0 µg/L, contamination in these wells cannot be considered confirmed.

1,1,1-trichloroethane was once again reported in MW-19 at 0.18J µg/L. MW-19 also had a detection of bromomethane at a reported concentration of 0.77J µg/L.

The TCE detected in MW-08 and MW-19 both exceed the MDEQ Part 201 RCDWC level of 5 µg/L but no other criteria were exceeded.

Inorganics: All of the samples collected in June were analyzed for perchlorate and all were reported with J-coded values between 0.011J µg/L (MW-14) and 0.077J µg/L (MW-07). These values were low enough and similar enough that, consistent with the J-code, apparently do not represent contamination.

4.2 CONCLUSION

The results from the June and August 2007 sampling periods are consistent with each other. Moreover, these results are consistent with the past data as presented in Section 2 except for the increase of TCE concentrations observed in MW-19. Hence, the location of the contaminant plume, based on results from the existing sampling network, have not changed since November of 2004, as reported in Earth Tech 2005.

5. SURFACE WATER INVESTIGATION

5.1 SUMMARY OF SURFACE WATER INVESTIGATION

VOCs were analyzed on the single sample collected. None were reported.

Metals were analyzed in the single sample collected. Lead (1.8B µg/L) and zinc (14.6B µg/L) were the only contaminant metals reported and both, as noted, were also present in the laboratory method blank. The only other inorganics reported were all commonly found soil elements such as Ca, Mg, Ba, Fe, and K. Concentrations of these elements were all within typical ranges for natural waters.

SVOCs were analyzed on the single sample collected—none were reported. Pesitcides/PCBs were also not detected.

5.2 CONCLUSION

These data indicate that the surface water sample location, the depression noted by Hiawatha National Forest personnel (see Sections 2 and 3), does not contain contaminated water.

6. GEOPHYSICAL INVESTIGATION

6.1 SUMMARY OF GEOPHYSICAL SCOPING SURVEY

On June 5, 2007, GeoModel, Inc., conducted an electromagnetic conductivity survey for GEO to detect a possible landfill at Raco AAF. The survey area was approximately 190 feet by 150 feet and was located in an isolated, wooded area. The location of the former dump area is provided in Figures 1-2 and 6-1.

A Geonics EM-31 terrain conductivity meter was used to obtain both ground conductivity data and metal detection data simultaneously to a depth of approximately 20 feet. The instrument was carried over the survey area along parallel staked survey lines spaced ten feet apart. Conductivity measurements were recorded in millimhos per meter (mmhos/m) and the metal detection values were measured in parts per thousand (ppt). These electromagnetic measurements were recorded on a Juniper Systems Pro4000 data logger. The field measurements were then downloaded from the data logger for processing and analysis.

Electromagnetic conductivity measurements taken during the survey area were processed into color contour maps of electromagnetic conductivity readings (Figure 6-2) and metal detection data (Figure 6-3).

Colors used on the electromagnetic contour maps illustrate relative ground conductivity readings and metal detection data. Readings in blue and green indicate areas of low conductivity or general background conditions in the survey area or lack of buried metal or debris. Any conductivity or metal detection readings that are in red, orange, or yellow would indicate anomalous areas of higher conductivity or buried metal or debris that would indicate possible landfill areas.

6.2 CONCLUSION

The electromagnetic conductivity values in the survey areas ranged from approximately 1 to 3 mmhos/m (blue and green colors). The metal detection values ranged from 4 to 6 ppt (blue and green colors). Both maps do not indicate any anomalous or elevated electromagnetic or metal detection data that would indicate the presence of a landfill in the survey area. The resultant survey data generally indicate background conditions.

7. RADIOLOGICAL INVESTIGATION

This section presents the results of a Radiological Scoping Survey performed on June 5, 2007 at the site of the former catch basins (Figures 1-2, 7-1, and 7-2). A representative of MDEQ, GEO, and a senior health physics technician from Science Applications International Corporation (SAIC) under subcontract to GEO investigated the area and determined that the increase in radiation detector response seen previously by the MDEQ was due to geometry effects when their radiation detector was placed inside of a depression in the ground. No evidence of residual radioactive materials was found in the area and MDEQ's concern has been addressed.

7.1 SUMMARY OF RADIOLOGICAL SCOPING SURVEY

Mr. W. Clark Evers of SAIC arrived at the Raco site on Tuesday, June 5, 2007. Mr. Evers met with Mr. Todd Calhoun of GEO and Mr. Matt Baltusis of the MDEQ. Mr. Evers performed quality control checks on his radiation instrument and the team then moved to the area of the former catch basins to begin the radiological scoping survey. A location map of the catch basin area is shown on Figure 7-1; photographs are shown on Figure 7-2.

The MDEQ radiation instrument used during the previous site visit was a Ludlum model 193-6 scaler with a model 44-132 probe head. This instrument resembles a metal-detector with a large flat head that is held close to the ground for scanning and measurements. The readout is in units of micro-REM/hr, but there is also an audible clicking response and a red light that flashes with each click of the meter. The primary SAIC instrument was a Ludlum model 2221 rate-meter with a model 44-10 detector (2" x 2" NaI). Instrument response check information for the SAIC instrument is provided in Appendix C of this report.

At the site of the former catch basins, the MDEQ instrument registered an audible response of about 10 counts-per-minute (cpm) above the depression. When the detector was placed into the depression, the audible response increased to about 50 to 60 cpm. For both measurements, the meter display remained at about 6 micro-REM/hr (e.g., no increase in radiation level above background).

The SAIC instrument registered a response of about 500 cpm above the depression, and about 1000 cpm when placed inside the depression. Scanning of the bottom of the depression showed no "hot spots".

A post-hole digger was then used to dig two new holes; one about 60 feet and the other about seven feet away from the catch basin depression (Test Holes #1 and #2; Figure 7-1). Surveys of these locations yielded results similar to that of the catch basin. MDEQ indicated that they concurred that the increased readings were indeed due to geometry effects and indicated their concern had been resolved.

7.2 CONCLUSION

The increase in radiation detector response (i.e., count-rate) observed by MDEQ at the site of the former catch basins was due to geometry effects. There is no indication of residual radioactive materials at that location.

8. QUALITY ASSURANCE SUMMARY REPORT

8.1 PURPOSE

Environmental data must be evaluated with respect to its limitations and intended use. To that end, monitoring data are scrutinized with respect to a series of QC and Quality Assurance (QA) measures. This report describes the QC and data verification procedures followed to ensure data obtained by GEO for the Raco AAF ESI satisfy project requirements. The quality of the data obtained (sensitivity, precision, accuracy) is described and any problems or non-conformances are highlighted.

Various actions were taken to acquire data of the desired quality. The Data Quality Objectives are defined in the Technical Project Planning Guidance for HTRW Data Quality Design, EM 200-1-2, 31 July 1995. Moreover, the quality of the collected data was designed to be such that it can be utilized in the preparation of environmental compliance documents. Upon receipt of the data, a verification review was conducted to ensure the data satisfied project requirements. These review steps are documented in this section.

8.2 QUALITY ASSURANCE PROGRAM

The initial step in the program was to prepare QC project documents (GEO 2007a) to ensure applicability to the personnel, activities, and documents called for by the SOW. In addition, a Sampling and Analysis Plan (GEO 2007b) was prepared which described the methods to be used for sampling and analysis. These documents listed the quantity and type of samples to be collected and defined the quantity and type of QA/QC samples to be used to evaluate the quality of the data obtained.

Field QC duplicates were collected. A VOC trip blank accompanied the cooler containing water samples for VOC determinations during the August 2007 event. Due to an oversight by the laboratory, no trip blanks were provided or included with the June 2007 event. Analytical laboratory QC duplicates, MS/MSDs, laboratory control samples (LCSs), and method blanks were required as specified in the DoD QSM V3.

The QC measures were adopted to ensure that data of known and sufficient quality were collected. The project included readiness review, training, equipment calibration, QC implementation, and detailed documentation. These measures ensured successful accomplishment of the goals established in the SOW.

8.3 LABORATORY "DEFINITIVE" LEVEL DATA REPORTING

TA-St. Louis, 13715 Rider Trail North, Earth City, MO 63045, was the primary analytical laboratory for the analysis of VOCs, SVOCs, PCBs, pesticides, and metals. TA-Denver, 1955 Yarrow Street, Arvada, CO 80002, was the primary analytical laboratory for the analysis of perchlorate. The data package received from each laboratory includes the following.

- laboratory case narratives
- sample results
- laboratory method blank results
- laboratory control sample (LCS) results
- laboratory sample MS recoveries
- laboratory duplicate results
- surrogate recoveries (VOCs, SVOCs, pesticides, PCBs)
- sample extraction dates
- sample analysis dates

This information from the laboratories, along with field information, provides the basis for subsequent data evaluation relative to sensitivity, precision, accuracy, representativeness, and completeness as presented below.

8.4 DATA VERIFICATION

The objective when evaluating the project data quality is to determine its usability. The evaluation is based on the interpretation of laboratory QC measures, field QC measures, and the project data quality objectives. This project implemented the Automatic Data Review (ADR) electronic review process in combination with technical oversight to facilitate laboratory data review. ADR output was reviewed by the project-designated verification staff and the project laboratory coordinator. The ADR product is retained in the project database and available within that structure. The ADR library and compatible EDDs are provided in Appendix B.

8.5 FIELD DATA VERIFICATION AND QUALITY ASSURANCE SAMPLES

Field-generated documents such as sampling logs, daily health and safety summaries, daily safety inspections, equipment calibration and maintenance logs, and sample management logs were peer reviewed on-site.

A single EB was collected during the June sampling event as described in Section 3. The only analyte reported in this sample was a J-coded value for toluene of 0.16J µg/L.

A single TB was provided by TA-St. Louis for the August sampling event as described in Section 3. The only analyte reported in this sample was a J-coded value for methylene chloride of 0.34J µg/L.

These results indicate no contamination occurred because of handling of equipment or samples in the field or during transportation.

8.6 LABORATORY DATA VERIFICATION

Analytical data generated for this project have been subjected to a process of data verification and review. The following describes this systematic process and the evaluation activities performed. Several criteria have been established against which the data were compared and from which a judgment was rendered regarding the acceptance and qualification of the data. These and project specific QC criteria are programmed into the database and evaluated using the ADR programming. Because it is beyond the scope of this report to cite those criteria, the reader is directed to the following documents for specific detail.

- USEPA – National Functional Guidelines for Inorganic Data Review, EPA 540/R-94/013, February 1994.
- USEPA – National Functional Guidelines for Organic Data Review, EPA 540/R-99/008, October 1999.

Upon receipt of field and analytical data, verification staff performed a systematic examination of the reports, utilizing the ADR process to ensure the content, presentation, and administrative validity of the data. Discrepancies identified during this process were recorded and documented. As part of data verification, standardized laboratory electronic data deliverables were subjected to review. This technical evaluation ensured that all contract-specified requirements had been met, and that electronic information conformed to reported hardcopy data.

During the verification phase of the review and evaluation process, data were subjected to a systematic technical review by examining all field and analytical QC results and laboratory

documentation, following USEPA functional guidelines and the ADR process. These data review guidelines define the technical review criteria, methods for evaluation of the criteria, and actions to be taken resulting from the review of these criteria. The primary objective of this phase was to assess and summarize the quality and reliability of the data for the intended use and to document factors that may affect the usability of the data. This process did not include in-depth review of raw data instrument out-put or recalculation of results from the primary instrument out-put. This data verification and analytical review process included, but was not necessarily limited to, the following parameters.

- data completeness
- analytical holding times and sample preservation
- calibration (initial and continuing)
- method blanks
- sample results verification
- surrogate recovery
- LCS analysis
- internal standard performance
- MS recovery
- duplicate analysis comparison
- reported detection limits
- compound, element, and isotope quantification
- reported detection levels
- secondary dilutions

As an end result of this phase of the review, the data were qualified based on the technical assessment of the verification/validation criteria. Qualifiers were applied to each field and analytical result to indicate the usability of the data for its intended purpose.

8.7 DEFINITION OF DATA QUALIFIERS (FLAGS)

During the data verification process, all laboratory data were assigned appropriate data qualification flags and reason codes. Qualification flags are defined as follows.

B (inorganics) = Analyte result is between the Contract Required Detection Limit (CRDL) and MDL

B (organics) = Compound was also detected in the method blank and the data should be interpreted with caution

D = Result was obtained from analysis of a dilution

J (organics) = Result is less than the EQL and is estimated

M (organics) = Sample matrix interfered with the quantitation limit

N (inorganics) = Spiked analyte recovery is outside of stated control limits

P (organics) = Associated numerical value is an estimated quantity

U (inorganics) = Analyte is reported down to the CRDL

U (organics) = Analyte was analyzed for but not detected or the concentration of the analyte quantitated below the MDL

8.8 DATA ACCEPTABILITY

Eighteen groundwater locations and one surface water location were sampled. In addition, various QC samples such as TBs and EBs were collected. Acceptable results were obtained for 100% of the sample analyses performed.

Table 8-1 lists the samples collected. Table 8-2 identifies a cross reference for duplicate and QA split sample pair numbers. Table 8-3 provides a summary of rejected analyses grouped by media and analyte category. The majority of estimated values were based on values observed between the laboratory method detection levels and the project reporting levels as specified in (GEO 2007b).

Table 8-1. Raco AAF sampling summary

Media	Environmental samples	Field duplicates	Trip blanks
Groundwater	18	2	1
Surface water	1	0	1

Table 8-2. Primary, duplicate, and split samples

Sample location	Event	Duplicate	MS/MSD
MW-08	June 2007	1	-
MW-10	June 2007	1	-
MW-19	June 2007	-	1/1
MW-08	August 2007	1	-
MW-19	August 2007	1	-
MW-18	August 2007	-	1/1

Samples were analyzed by SLT-St. Louis for VOCs, SVOCs, PCBs, pesticides, and metals. Samples were analyzed by TA-Denver for perchlorate.

Table 8-3. Raco AAF summary of rejected analytes (laboratory).

Media	Analysis group	Rejected	Total	Percent Rejected (%)
Groundwater and Surface Water	VOCs	0	0	0
	SVOCs	0	0	0
	Pesticides/Herbicides	0	0	0
	PCBs	0	0	0
	Metals	0	0	0
	Chloride	0	0	0
	Cyanide	0	0	0
	Sulfate	0	0	0
Project Total		0	0	0

Grouped by medium and analysis group.

Samples were collected on June 5, 2007 (groundwater and surface water) and August 8, 2007 (groundwater only). Locations for the groundwater sampling had been previously verified with Mr. Joseph Bohannon, CELRL; the surface water sampling location (subsidence area) was verified with Ms. Jessica Stuntebeck of the Hiawatha National Forest during the June 2007 event.

8.9 DATA QUALITY EVALUATION

This subsection provides the laboratory-prepared case narrative for quality assurance evaluation. Despite certain nonconformances, all results were reportable based on the data review guidelines referenced in Section 3 of this report except for MW-20 from the August sampling period. The data from MW-20 in August, however, was consistent with both the June data and historical results.

8.9.1 Samples Collected June 2007, Lot Number F7F070365

Twenty-two samples were received under chain of custody by TA-St. Louis on June 7, 2007. The laboratory case narrative asserted that the "analytical results included in [their] report [met] all applicable quality control procedure requirements except as noted [below]." In addition, the test results met all National Environmental Laboratory Accreditation Program (NELAP) requirements for parameters in which accreditations are held by TA-St. Louis. Any exceptions to NELAP requirements were also noted in the case narrative.

Observations/Nonconformance

The chain of custody and condition upon receipt report has been provided with the raw data. There were no issues with receipt conditions and temperature of samples on receipt.

8.9.1.1 Organochlorine Pesticides by Gas Chromatograph (GC) (SW846 8081A)

Batch 7163407:

The MS/MSD recovery for Heptachlor is outside the established QC limits. The relative percent difference (RPD) is within method acceptance criteria indicating a possible matrix interference. Method performance is demonstrated by acceptable LCS recovery.

Affected Samples:

F7F070365 (21): RASW01010706

8.9.1.2 PCBs by GC (SW846 8082)

Batch 7163412:

The ICV fails for the following compounds:

4-Chloroaniline 43.62%

Hexachlorocyclopentadiene 33.17%

3-Nitroaniline 30.74%

3,3-Dichlorobenzidine 41.29%

Half volume was used for MS and MSD due to insufficient volume.

Affected Samples:

F7F070365 (21): RAWS01010706

8.9.1.3 Semivolatile Organics by GC/Mass Spectrometer (MS) (SW846 8270C)

In BNA batch 7163405, half volume was used for MD/MSD due to insufficient volume.

Affected Samples:

F7F070365 (21): RASW01010706

8.9.1.4 Trace ICP Metals (SW846 6010B)

Batch 7159296:

The sample was analyzed after dilution for aluminum, iron, potassium and sodium due to high concentrations of the target analytes iron and sodium. The reporting limit has been adjusted only for those targets reported from the dilution run.

The MS (MSD) recovery for iron is outside the established QC limits. The analyte concentration in the original sample is greater than four times the amount spiked, making percent recovery information ineffective. Method performance is demonstrated by acceptable LCS recovery.

The serial dilution for potassium is outside of method acceptance criteria indicating a potential matrix interference. All associated samples are flagged accordingly.

Affected Samples:

F7F070365 (21): RASW01010706

8.9.1.5 Volatile Organics by Gas Chromatograph/Mass Spectrometer (GC/MS) (SW846 8260B)

Batch 7172535:

The D% in continuous calibration verification (CCV) was outside the QC limit (greater than 20% D) for Freon-114 (133% high), bromomethane (41% low), chloroethane (28% low), diethyl ether (20.9% low), methyl acetate (93.7% high), bromochloromethane (27.8% high), ethyl acetate (43.6% low), carbon tetrachloride (40% high, 1,1,1-trichloroethane (24.6% high), bromodichloromethane (20.8% high), 2-chloroethyl vinyl ether (42.1% low), chlorodibromomethane (31.3% high), 1,1,1,2-tetrachloroethane (25.0% high), cyclohexanone (23.1% low), 1,2-dibromo-3-chloropropane (20.7% high), hexachlorobutadiene (25.8% high), nonanal (140% high). These analytes were either not detected above the reporting limit or not the target analytes in the associated samples.

The LCS analyte, carbon tetrachloride, and laboratory control sample duplicate (LCSD) analytes, methyl acetate and trichlorofluoromethane, recovered high, indicating a potential positive bias for those analytes. These analytes were not observed above the reporting limit in the associated samples. Ethyl acetate in the LCS/LCSD recovered low; it is not a target analyte. Therefore, the sample data were not adversely affected by this excursion.

The MS recovery for methyl acetate is outside the upper QC limit, indicating a potential positive bias for that analyte. This analyte was not observed above the reporting limit in the associated samples. Ethyl acetate recoveries in the MS/MSD are below the QC limits - it is not a target analyte. 2-chloroethyl vinyl ether is not detected in the MS/MSD due to the sample preservation (hydrochloric acid).

The MS/MSD RPD for four compounds is outside of the QC limits - recoveries are within the QC limits.

Affected Samples:

F7F070365 (20): RAGW02010706

Batch 7171239:

The D% in CCV was outside the QC limit (greater than 20% RSD) for Freon-114 (126% high), bromomethane (47.0% Low), chloroethane (23.2% low), methylene chloride (22.1% high), bromochloromethane (27.5% high), ethyl acetate (50.2% low), carbon tetrachloride (27.2% high), chlorodibromomethane (21.3% high), n-propylbenzene (22.3% low), 1,1,2,2-tetrachloroethane (25.6% low), trans-1,4-dichloro-2-butene (32.8% low), cyclohexanone (28.3% low), hexachlorobutadiene (22.1% high), nonanal (123% high). These analytes were either not detected or not reported in the associated samples.

The LCS/LCSD analyte methyl acetate recovered high, indicating a potential positive bias for that analyte. This analyte was not observed above the reporting limit in the associated samples. Ethyl acetate recovered low; it is not a target analyte. Therefore the sample data was not adversely affected by this excursion.

Affected Samples:

F7F070365 (1): RAGW05010706
F7F070365 (2): RAGW06010706
F7F070365 (3): RAGW07010706
F7F070365 (4): RAGW08010706
F7F070365 (5): RAGW08020706
F7F070365 (6): RAGW09010706
F7F070365 (7): RAGW10010706
F7F070365 (8): RAGW10020706
F7F070365 (9): RAGW11010706
F7F070365 (10): RAGW12010706

Batch 7171241:

The D% CCV was outside was outside the upper QC limit (greater than 20% D) for Freon-114 (102% high), bromomethane (45.2% low), chloroethane (26.8% low), acrolein (22.6% low), methyl acetate (56.7% high), bromochloromethane (21.7% high), ethyl acetate (51.5% low), carbon tetrachloride (27.4% high), 2-butanone (30.5% low), 2-chloroethyl vinyl ether (27.0% low), chlorodibromomethane (24.0% high), n-propylbenzene (21.1% low), 1,1,2,2-tetrachloroethane (21.6% low), trans-1,4-dichloro-2-butene (24.5% low), cyclohexanone (23.4% low), hexachlorobutadiene (23.5% high), nonanal (131% high). These analytes were either not detected above the reporting limits or not the target analytes in the associated samples.

The Method Blank surrogate recovery for toluene-d8 is outside acceptable limits (84.0%). Samples, associated with this method blank, demonstrated acceptable surrogate recoveries indicating the surrogate excursion is isolated to the method blank and not indicative of the batch.

The LCS/LCSD analyte recoveries for methyl acetate were high indicating a potential positive bias for that analyte. This analyte was not observed above the reporting limit in the associated samples. Ethyl acetate recovered low; this analyte is not a target analyte. Therefore the sample data were not adversely affected by this excursion.

The MS and MSD recoveries for several compounds are outside the established QC limits. 2-chloroethyl vinyl ether is not detected in the MS/MSD due to the sample preservation (hydrochloric acid). The RPD for two compounds are not within method acceptance criteria indicating a possible matrix interference. Method performance is demonstrated by acceptable LCS/LCSD recovery.

Affected Samples:

F7F070365 (11): RAGW14010706
F7F070365 (12): RAGW15010706
F7F070365 (13): RAGW16010706
F7F070365 (14): RAGW17010706
F7F070365 (15): RAGW18010706
F7F070365 (16): RAGW19010706
F7F070365 (17): RAGW20010706
F7F070365 (18): RAGW21010706
F7F070365 (19): RAGW22010706
F7F070365 (20): RAGW02010706
F7F070365 (21): RASW01010706
F7F070365 (22): RAEB01020706

According to the nature of the Chemicals of Concern, the sample was presumed to be preserved to a pH<2. Due to the potential loss of volatile constituents, VOA vials are not checked for pH preservation until the time of analysis. The sample pH was not less than 2, resulting in the analysis being performed outside the 7 day holding time for unpreserved samples.

Affected Samples:

F7F070365 (17): RAGW20010706

8.9.2 Samples Collected August 2007, Lot Number F7H080283

Twenty-one samples were received under chain of custody by TA St. Louis on August 8, 2007.

The analytical results included in the report met all applicable quality control procedure requirements except as noted below. Furthermore, the test results met all NELAP requirements for parameters in which accreditations are held by TA St. Louis. Any exceptions to NELAP requirements are noted below.

Observations/Nonconformances

The chain of custody and condition upon receipt report has been provided with the raw data. There were no issues with receipt conditions and temperature of samples on receipt.

8.9.2.1 Volatile Organics by GC/MS (SW846 8260B)

Batch 7226195, 7226466, 722646:

The D% CCV was (higher recovered) outside the Method criteria (greater than 20% D) for several compounds indicating a potential high bias for those analytes in the samples associated with the CCV. These samples were either not detected above the reporting limit or not reported in the associated samples.

The LCS/LCSD recoveries for acetone, chloromethane, iodomethane, arolein, 1-butanol are too high. Iodomethane failed high in the MS/MSD. The analytes were not observed above the reporting limits or not reported in the associated samples; therefore the sample data was not adversely affected by this excursion. The original sample results are provided.

Affected Samples:

F7H080283 (1): RAGW15010708
F7H080283 (2): RAGW16010708
F7H080283 (3): RAGW17010708
F7H080283 (4): RAGW18010708
F7H080283 (5): RAGW19010708
F7H080283 (6): RAGW19020708
F7H080283 (7): RAGW20010708
F7H080283 (8): RAGW21010708
F7H080283 (10): RAGW02010708
F7H080283 (11): RAGW05010708
F7H080283 (12): RAGW06010708
F7H080283 (13): RAGW07010708
F7H080283 (14): RAGW08010708
F7H080283 (15): RAGW08020708

Batch 7229233, 7232575:

The D% CCV was (higher recovered) outside the Method criteria (greater than 20% D) for several compounds indicating a potential high bias for those analytes in the samples associated with this CCV. These analytes were either not detected above the reporting limit or not reported in the associated samples.

Affected Samples:

F7H080283 (9): RAGW22010708
F7H080283 (16): RAGW09010708
F7H080283 (17): RAGW10010708
F7H080283 (18): RAGW11010708
F7H080283 (19): RAGW12010708
F7H080283 (20): RAGW14010708
F7H080283 (21): RATB01020708

Batch 7229233:

The MS and MSD recoveries for trichloroethene and cis-1,2-dichloroethene are outside the established QC limits. Method performance is demonstrated by acceptable LCS recovery.

Affected Samples:

F7H080283 (9): RAGW22010708
F7H080283 (16): RAGW09010708
F7H080283 (17): RAGW10010708
F7H080283 (18): RAGW11010708
F7H080283 (19): RAGW12010708
F7H080283 (20): RAGW14010708
F7H080283 (21): RATB01020708

8.10 PRECISION

Field duplicate samples were collected to ascertain the contribution to variability (i.e., precision) due to the combination of environmental media, sampling consistency, and analytical precision. The field duplicates were collected from the same spatial and temporal conditions as the primary environmental samples. Groundwater wells MW-08 and MW-10, during the June 2007 event, and MW-08 and MW-19, during the August 2007 event, were analyzed as duplicate samples by TA-St. Louis and TA-Denver (perchlorate only).

Field duplicate comparison information in Table 8-4 presents the absolute difference or RPD for field duplicate measurements by analyte. RPD was calculated only when both samples were not qualified. In general, the values should be > 5 times the reporting level for a meaningful RPD. If both samples were not detected for a given analyte, precision was considered acceptable. To review the information in Table 8-4, this report has implemented general criteria for comparison of RPD with a criterion of 40. The table

compares all analytes where at least one value was not qualified with a U, B, or J. As the table shows, all duplicate RPD comparisons are acceptable.

Table 8-4. Field duplicate comparison/split sample comparison – Raco AAF ESI (results provided are µg/L except for nitrate, fluoride, chloride and sulfate which are mg/L)

	June Duplicates		August Duplicates	
Analyte	**MW-8/ MW-8 dup RPD***	**MW-10/ MW-10 dup RPD***	**MW-8/ MW-8 dup RPD***	**MW-19/ MW-19 dup RPD***
trichloroethene	18/19 5.4		12/12 0	33/32 3.2
acetone		4.3/ND N/A		

*RPDs < 40 are acceptable for water samples as specified in the Louisville Chemistry Guidelines, v.5, June 2002

8.11 SENSITIVITY

Determination of minimum detectable values allows the investigation to assess the relative confidence that can be placed in a value relative to the magnitude or level of analyte concentration observed. The closer a measured value comes to the minimum detectable concentration, the less confidence and more variation the measurement will have. Project sensitivity goals were expressed as quantitation level goals in the QA documentation. These levels were achieved or exceeded throughout the analytical process. Actual laboratory method detection level achieved during this investigation achieved project quantitation level goals. Individual analyte reporting levels varied due to contaminant analyte concentrations.

Method blank determinations were performed with each sample batch for each analyte under investigation. These blanks were evaluated during data review to determine their potential impact on individual data points, if any. Review action levels are set at 5 times the reporting level for all analytes, except those designated as common laboratory contaminants (methylene chloride, acetone, toluene, 2-butanone, and phthalate compounds) with action levels set at 10 times reporting levels. During data review, reported sample concentrations are assessed against method blank action levels and the following qualifications are made when reportable quantities of analyte were observed in the associated method blank.

- When the analyte sample concentration is above 5 or 10 times the action level, the data are not qualified and it is considered a positive value.
- When the analyte sample concentration is determined below 5 or 10 times the action level but above the reporting level, the data are considered impacted by the method blank and the value reported is qualified as a non-detect at the analyte value reported. These data are then qualified accordingly.
- When the analyte sample concentration is determined below 5 or 10 times the action level and below the reporting level, the data are considered impacted by the method blank and the value reported is qualified as a non-detect at the reporting level. These data are then qualified accordingly.

8.12 REPRESENTATIVENESS AND COMPARABILITY

Representativeness expresses the degree to which data accurately reflect the analyte or parameter of interest for the environmental site and is the qualitative term most concerned with the proper design of the sampling program. Factors that affect the representativeness of analytical data include proper preservation, holding times, use of standard sampling and analytical methods, and determination of matrix or analyte interferences. Samples were delivered to the laboratory by overnight express courier, were received in good condition, and at appropriate temperature. All analyses were performed within the recommended analytical holding times. Sample preservation, analytical methodologies, and sampling methodologies were documented to be adequate and consistently applied.

Comparability, like representativeness, is a qualitative term relative to an individual project data set. This sampling program employed appropriate sampling methodologies, site surveillance, use of standard sampling devices, uniform training, documentation of sampling, standard analytical protocols/procedures, QC checks with standard control limits, and universally accepted data reporting units to ensure comparability to other data sets. Through the proper implementation and documentation of these standard practices, the project has established the confidence that the data will be comparable to other project and programmatic information.

8.13 COMPLETENESS

Usable data are defined as those data that pass individual scrutiny during the verification and validation process and are accepted for unrestricted application to the human health risk assessment evaluation or equivalent type applications. The only completeness issue was with MW-20 during the August sampling. Samples are to be preserved at pH <2 or analyzed within seven days. This sample was found by the laboratory to be pH >2 and, hence, the analysis occurred outside of the holding time for an unpreserved sample. A trace (<1 µg/L) was reported in this sample and J-coded. Because this well was not expected to be contaminated based both on the June 2007 data and on historical data (Section 2), the August result of no reportable contaminants is consistent. Therefore, the objectives for the Raco AAF monitoring data are considered achieved. The project produced usable results for the samples collected and analyses were performed successfully for all the samples planned.

8.14 DATA QUALITY ASSESSMENT SUMMARY

The overall quality of the Raco AAF monitoring information meets or exceeds the established project objectives. Through proper implementation of the project data verification and assessment process, project information has been determined to be acceptable for use.

Data, as presented, have been qualified as usable or estimated. Data that have been estimated indicate accuracy, precision, or sensitivity are less than desired but adequate for interpretation. Qualifiers have been applied to data as appropriate.

Data produced for this project can withstand scientific scrutiny, are appropriate for its intended purpose, are technically defensible, and are of known and acceptable sensitivity, precision, and accuracy. Data integrity has been documented through proper implementation of QA and QC measures. The environmental information presented has an established confidence that allows utilization for the project objectives and provides data for future needs.

9. REFERENCES

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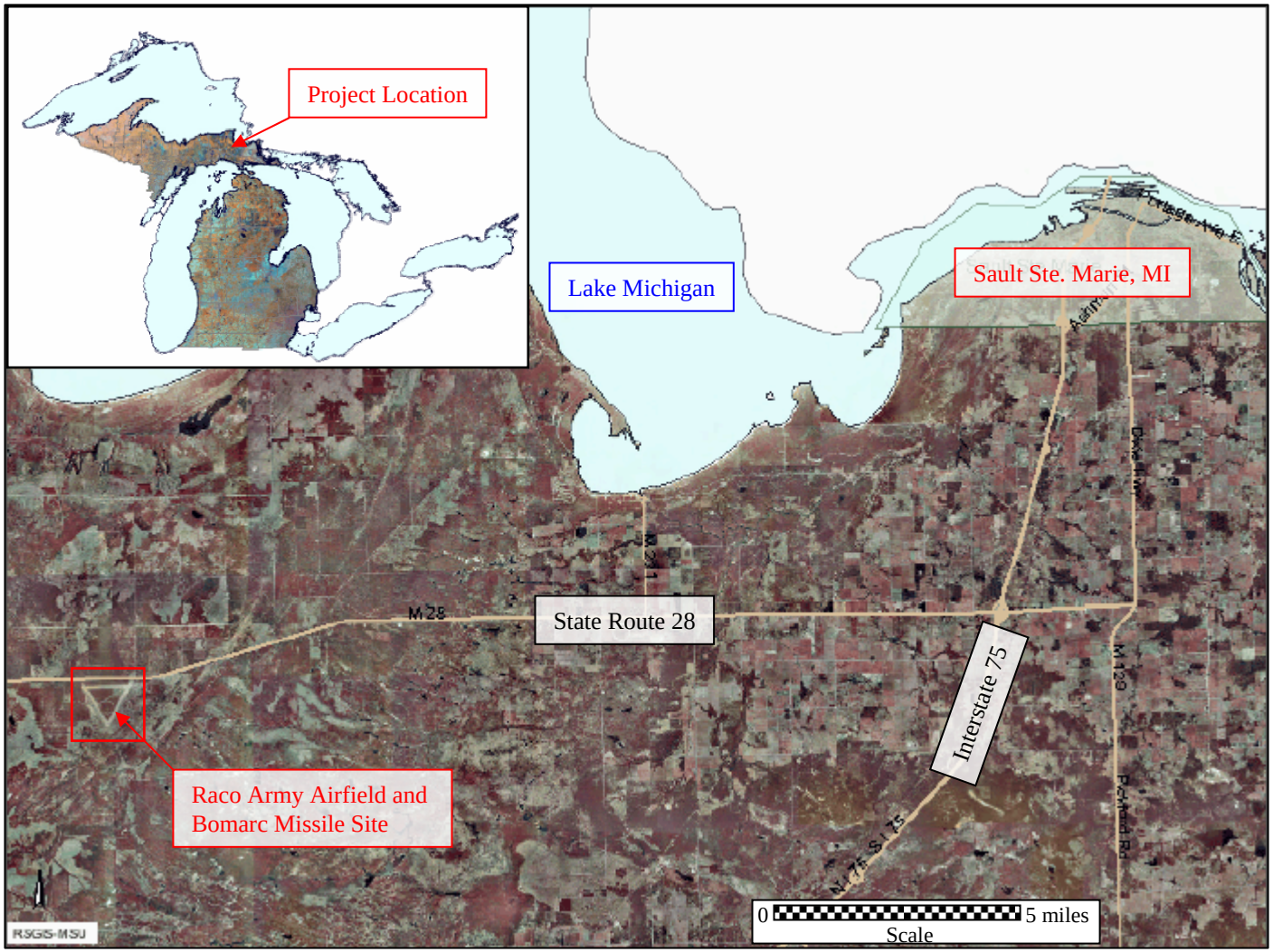
APPENDICES

APPENDIX A

FIGURES



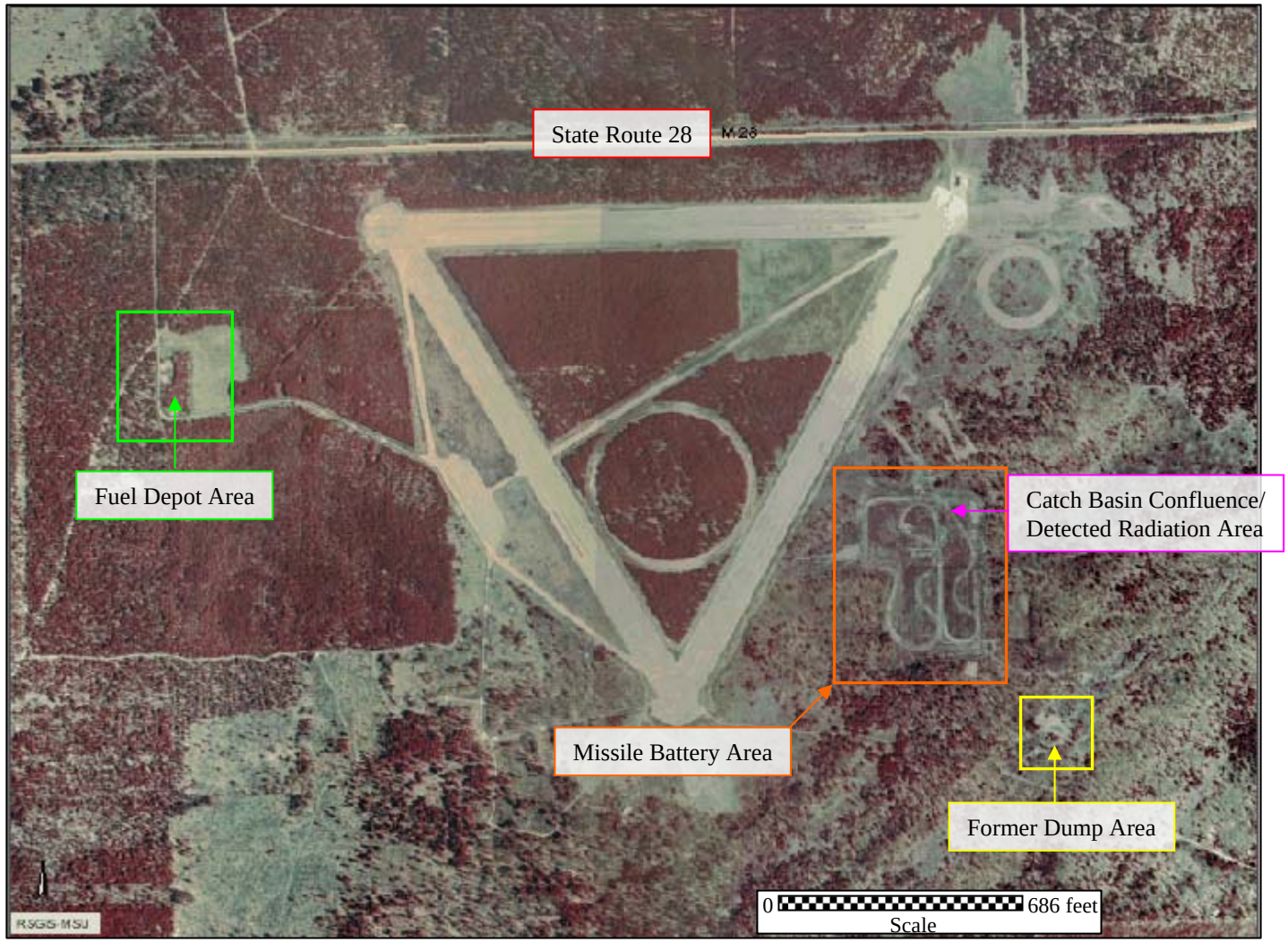
Base maps: USGS 1998 Digital Orthophoto Quadrangle Series. Obtained from Michigan Remote Sensing and Geographic Information Science Research and Outreach Services.

Figure 1-1 Site location map for Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site Raco, Michigan



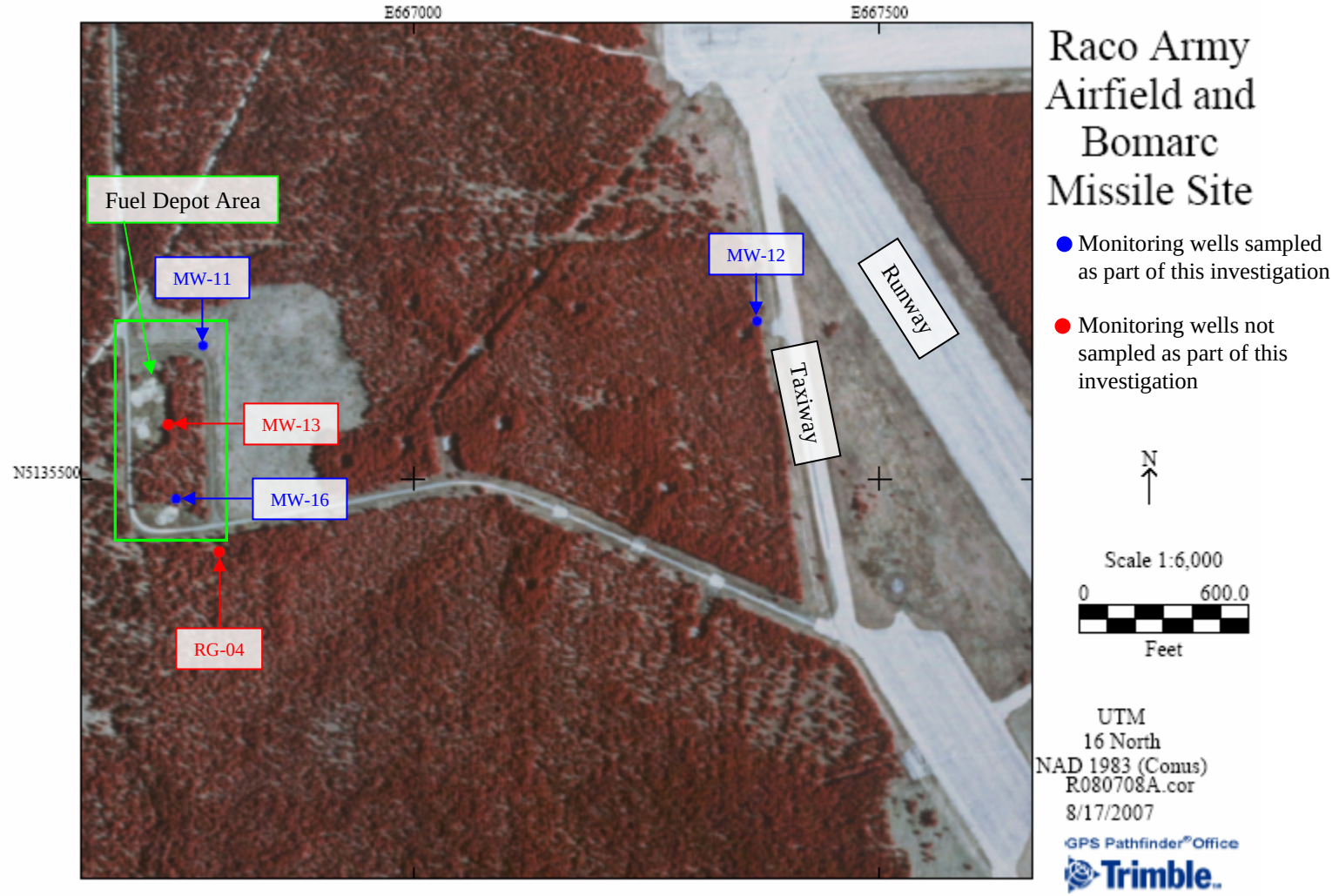
Base maps: USGS Sullivan Creek NE and Sullivan Creek NW 1998 Digital Orthophoto Quadrangle Series. Obtained from Michigan Remote Sensing and Geographic Information Science Research and Outreach Services.

Figure 1-2 Site vicinity map for Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan



Base map: USGS Seamless DOQQ

Figure 1-3 Fuel Depot Area at Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan

Base map: USGS Seamless DOQQ.

Figure 1-4 Missile Battery Area at Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan

Base map: USGS Seamless DOQQ.

Figure 1-5 Surface Water Sampling at Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
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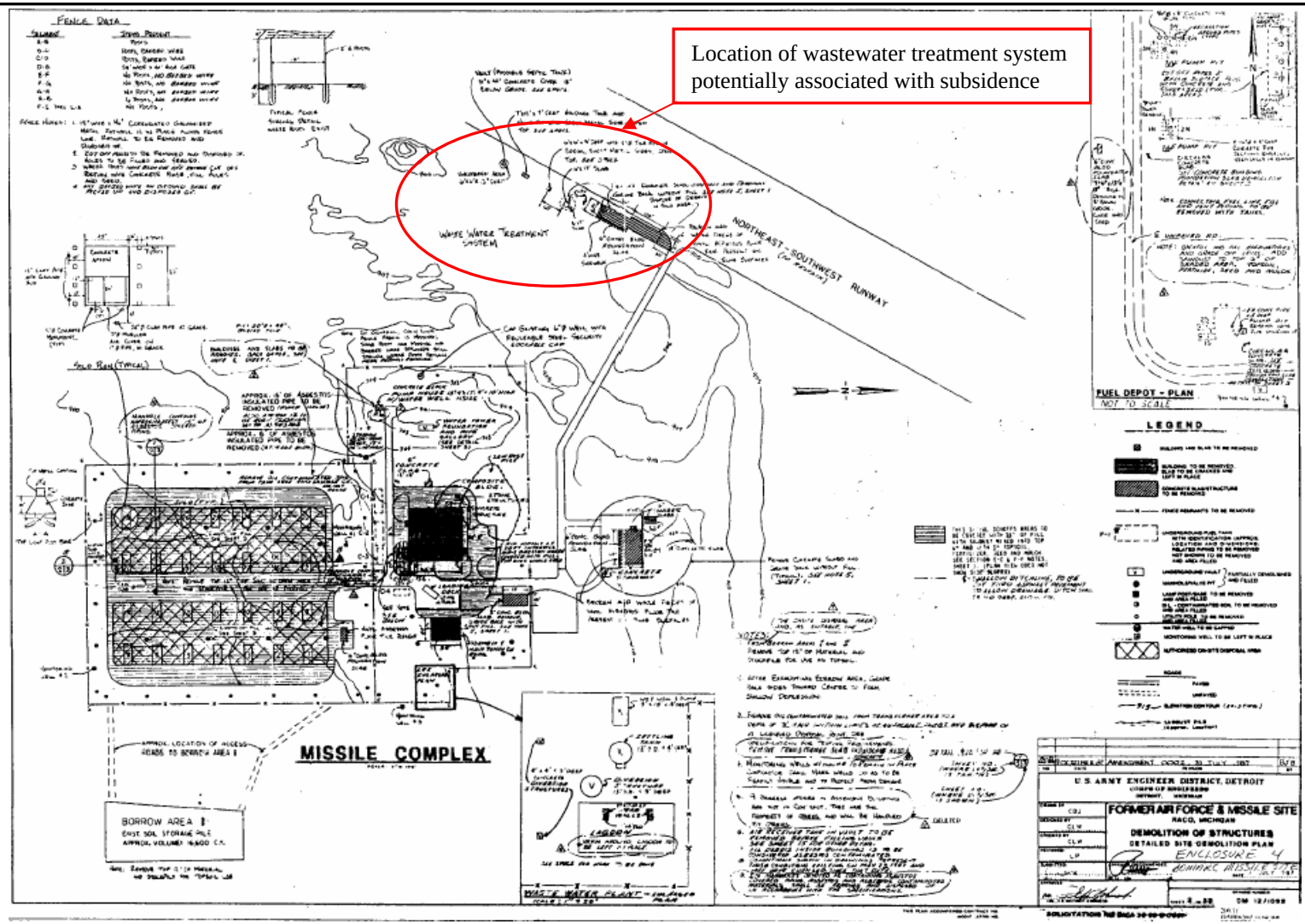
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan



Source: Former Air Force & Missile Site, Raco, Michigan, Demolition of Structures, Detailed Site Demolition Plan, July 1987. Provided by Michigan Department of Environmental Quality.

Figure 1-6 Historical Site Drawing Showing Location of Former Waste Water Treatment System

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan

(a) Photograph 1

(b) Photograph 2

(c) Photograph 3

(d) Photograph 4

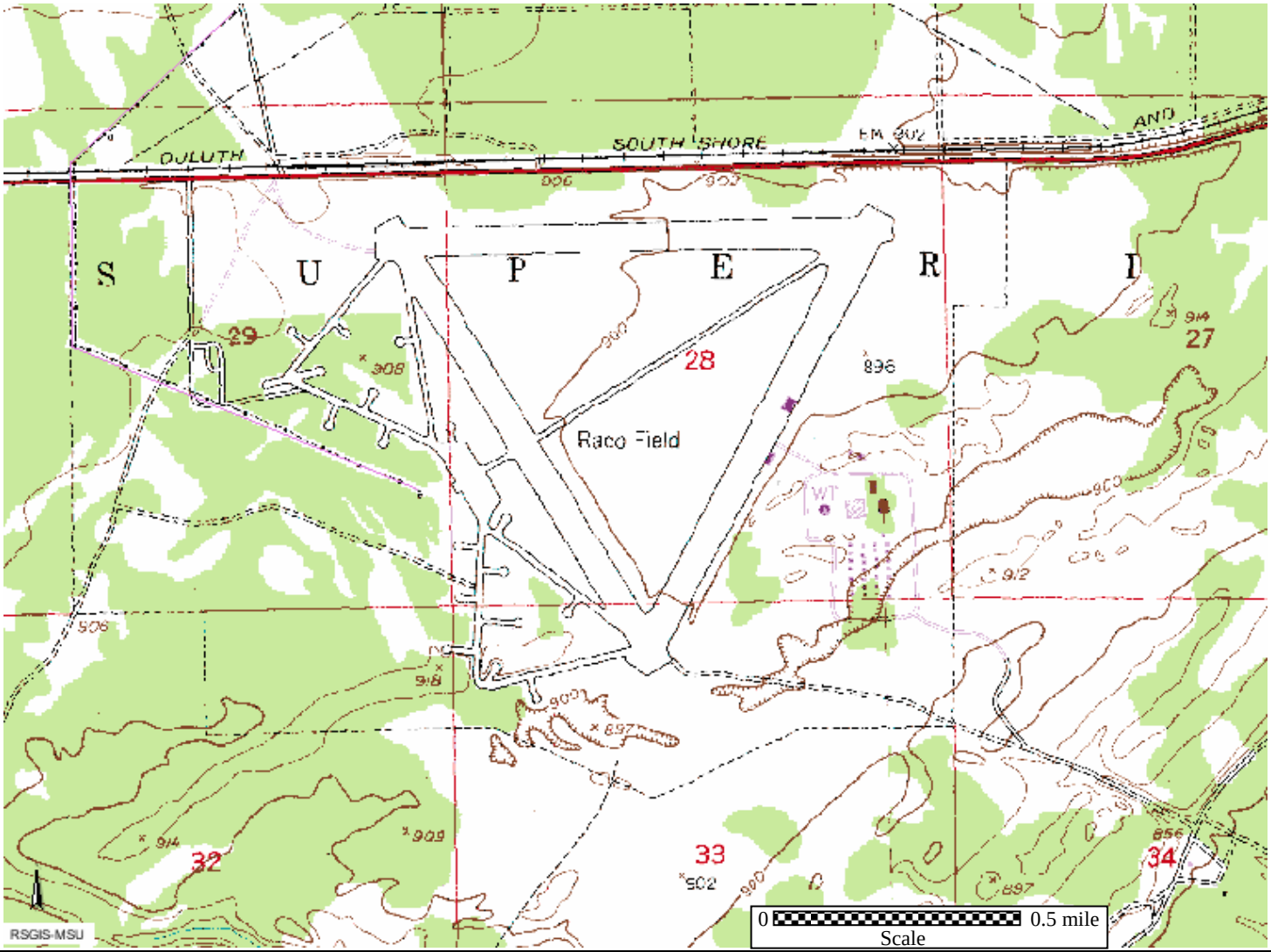
Source: Hiawatha National Forest/GEO

Figure 1-7 Subsidence photographs at Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan



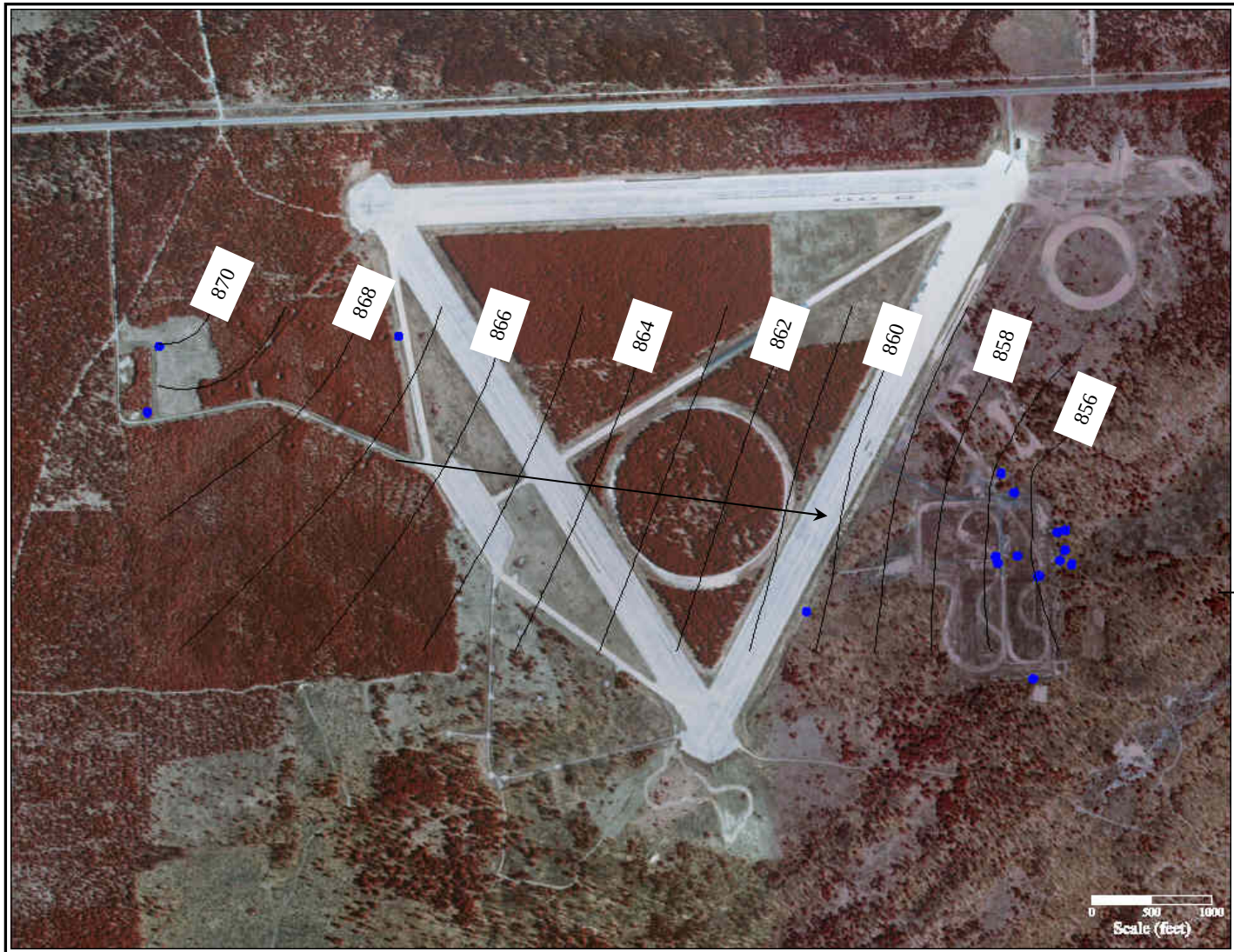
Base map: USGS Sullivan Creek Topographic Quadrangle Map obtained from Michigan Department of Natural Resources online database.

Figure 2-1 Topographic map for Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site Raco, Michigan



LEGEND

- Monitoring well locations
- Groundwater flow direction
- 860 Potentiometric surface contour in feet above mean sea level

Contour Interval = 1 ft

N

Base map: USGS Seamless DOQQ.

Figure 3-1 Potentiometric Surface – June 4, 2007

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
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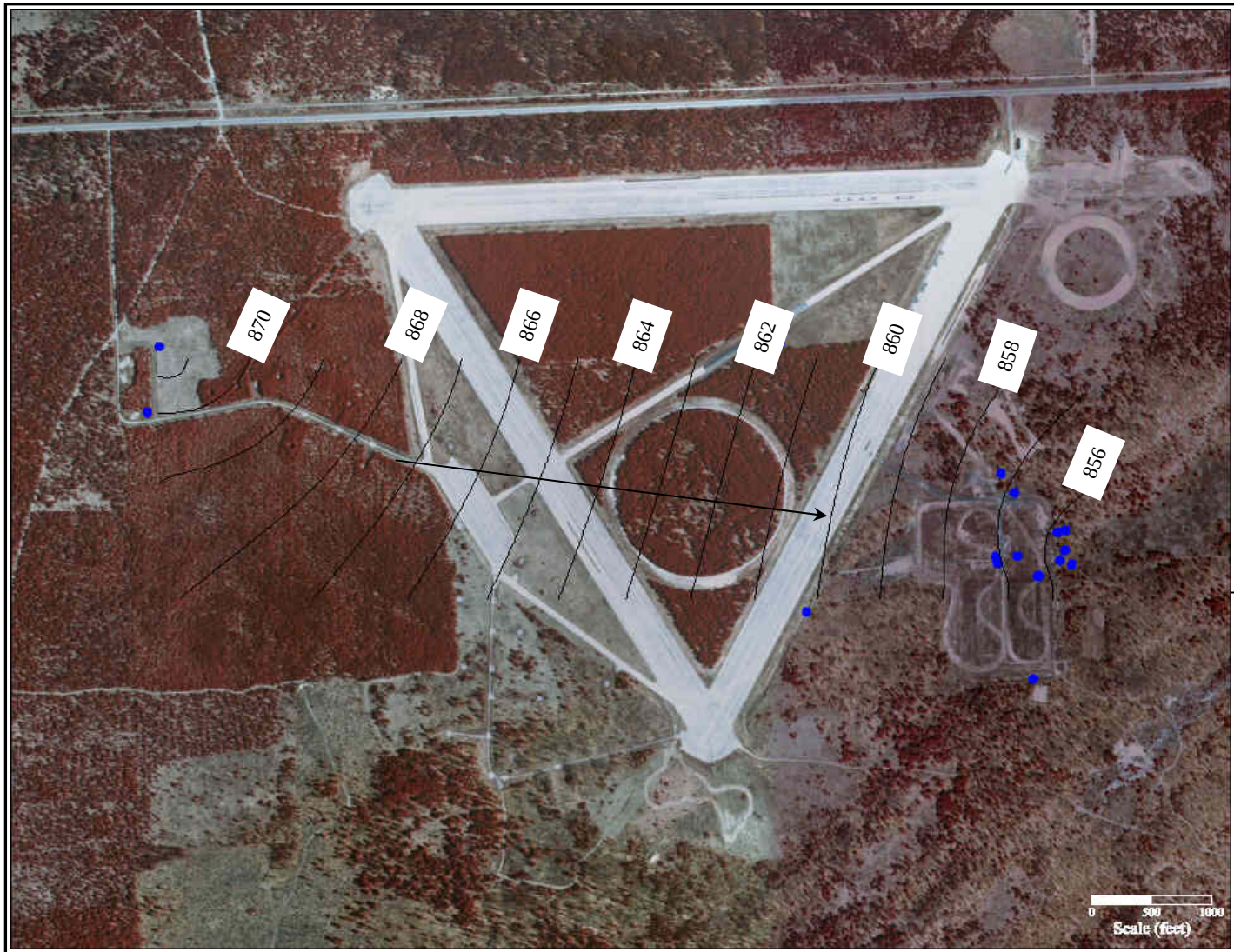
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan



LEGEND

- Monitoring well locations
- Groundwater flow direction
- 860 Potentiometric surface contour in feet above mean sea level

Contour Interval = 1 ft

N

Base map: USGS Seamless DOQQ.

Figure 3-2 Potentiometric Surface – August 7, 2007

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
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Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan

Base map: USGS Seamless DOQQ.

Figure 6-1 Former Dump Area at Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan

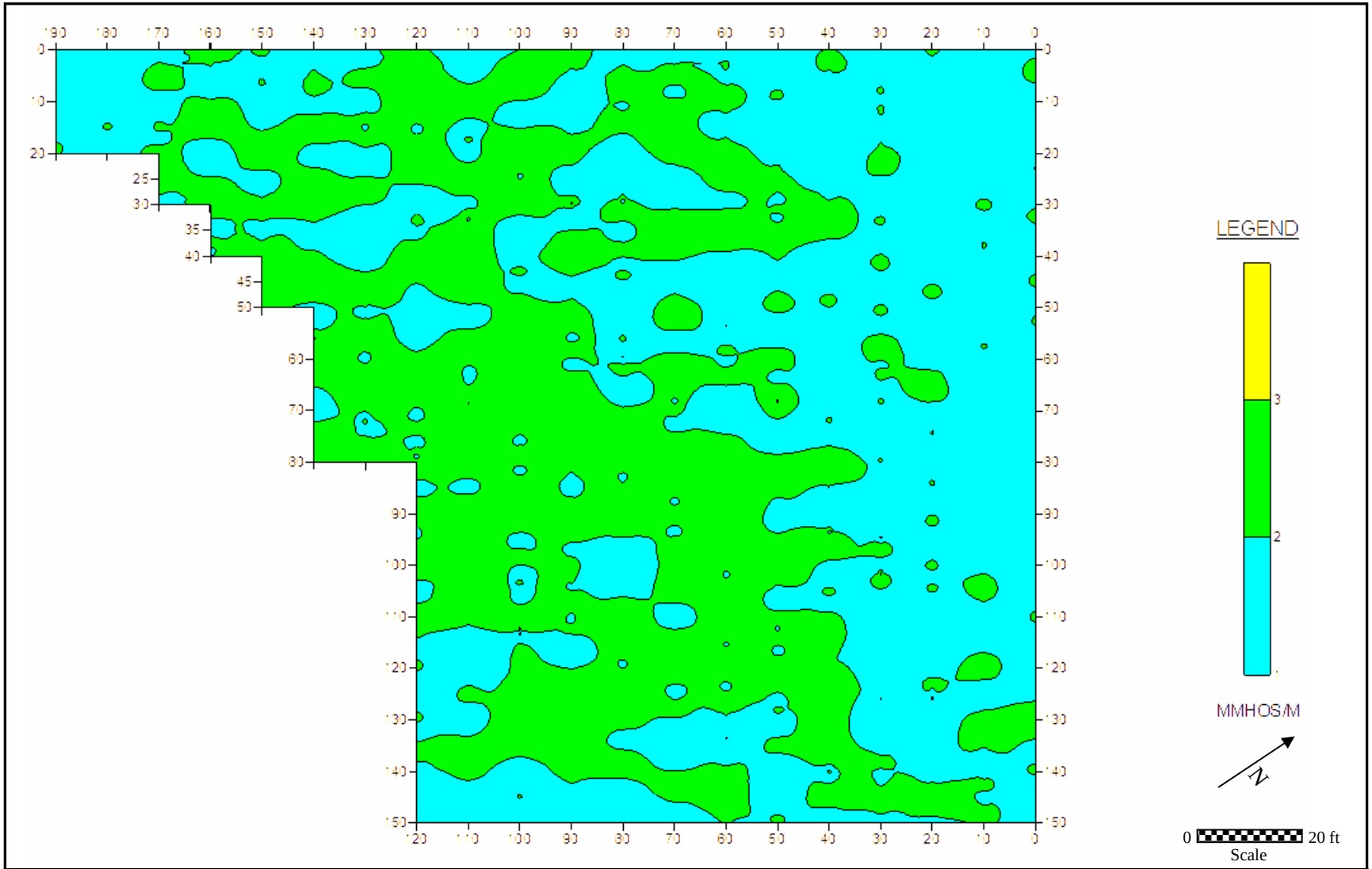


Figure 6-2 Former Dump Area EM-31 Conductivity Data at Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan

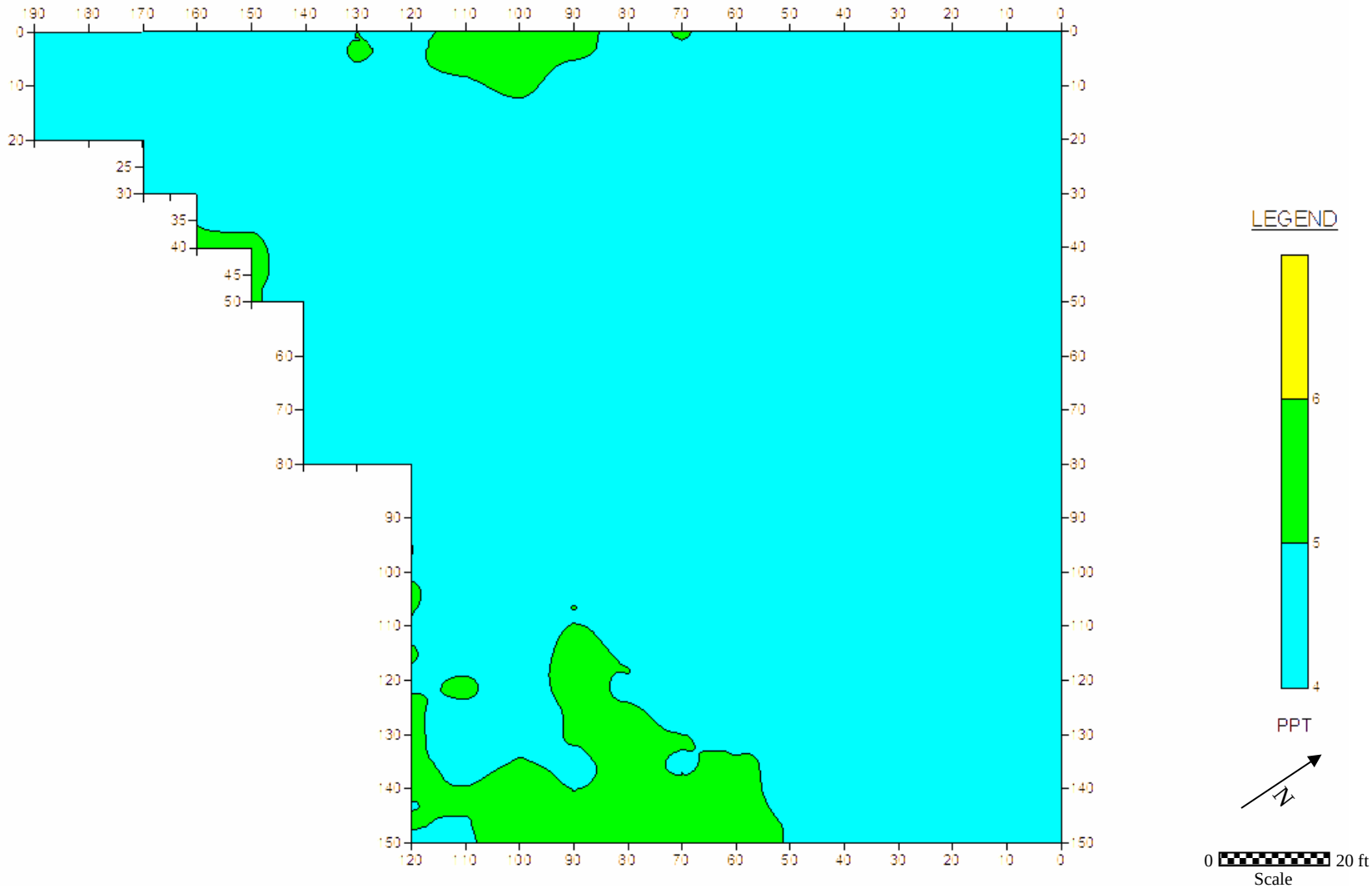


Figure 6-3 Former Dump Area EM-31 Metal Detection Data at Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan

Base map: USGS Seamless DOQQ

Figure 7-1 Catch Basin Confluence/Detected Radiation Area at Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan

(a) Photograph 1

(b) Photograph 2

(c) Photograph 3

(d) Photograph 4

Figure 7-2 Catch basin area photographs at Raco Army Airfield and Bomarc Missile Site

U.S. Army Corps of Engineers
Louisville District

GEO Consultants, LLC
A Geological Engineering and Environmental Services Company
Kevil, Kentucky

Raco Army Airfield and Bomarc Missile Site
Raco, Michigan

APPENDIX B

ANALYTICAL LABORATORY DATA

(provided electronically)

APPENDIX C

FIELD DATA

Raco Army Airfield and Bomarc Missile Site
Existing monitoring well coordinates

Monitoring Well ID	Easting	Northing
RG-01*	668851.656	5135058.328
RG-02	668940.831	5134818.194
RG-03*	669004.186	5135107.166
RG-04*	666791.817	5135422.883
MW-05	668860.922	5135327.742
MW-06	668847.653	5135121.653
MW-07	668902.160	5135123.112
MW-08	669007.348	5135111.988
MW-09	668379.221	5134984.595
MW-10	668312.333	5135646.943
MW-11	666774.825	5135642.695
MW-12	667368.620	5135668.035
MW-13*	666737.459	5135558.201
MW-14	669020.417	5135187.024
MW-15	668853.094	5135105.369
MW-16	666745.602	5135478.755
MW-17	668893.817	5135279.938
MW-18	668951.180	5135072.186
MW-19	669019.534	5135137.679
MW-20	669036.061	5135101.965
MW-21	669000.986	5135181.970
MW-22	668955.755	5135073.772

Coordinate System: UTM 16N NAD83
*Not sampled as part of this investigation

Zone MAF ESI

QUANTA DAILY CALIBRATION

Hydrolab # GEO-461-1
GEO-461-2
GEO-461-3

By TC JH BG MC JB VM RT JB
Date: 6-5-07

pH CALIBRATION

Buffer +/- .1 SU	Lot #	Exp. Date	Vendor	Time	Temp (Celsius)	pH	Adj. To
pH 4	4520	8-08	F	0803	12.41	3.94	4.00
pH 7	063709	7-08	F	0800	12.58	7.30	7.00
pH 10	060732	2-08	F	0806	12.46	10.14	10.00

D.O. AIR CALIBRATION

Solution Temp (C): 12.31 Local B.P.: 29.29 (743.95)

% Saturation: 100% % Saturation (fixed): 100%

DO mg/l Reading (+/- 0.2 mg/l) 10.5 @ 12.31 Deg Celsius

Does reading meet DO Saturation Values acceptance criteria? _____Yes _____No
If No, Recalibrate or check Operations Manual for maintenance.

CONDUCTIVITY CALIBRATION

Standard Value:
1412 (umhos) 1.412 (mS) Lot # 1704195 Exp: 3-08 Manufacturer: Ricca

Temperature(C): 11.37 Conductivity(+/- 20 umhos): 0807 Adjusted To: 1412

TURBIDITY CALIBRATION PERFORMANCE CHECK

4-Beam Turbidity Quick-Cal Cube QCC#:81181

GEO 461-1=75.0 +/- 20%
GEO 461-2=77.9 +/- 20%
GEO 461-3=77.0 +/- 20%

Reading 77.0 NTU

✓ Reading is within acceptance criteria of the Quick-Cal Cube for the instrument to be used.

_____Reading is not within acceptance criteria of the Quick-Cal Cube for the instrument to be used. If reading is not within the Quick-Cal Cube acceptance criteria, perform primary calibration according to operational manual.

ORP Calibration

ZoBell Solution:
Lot #: 1702831 Expiration Date: 11-07

ZoBell Solution's ORP Value: 237 +/- 10 mV @ 20 Deg C

Reading Prior to Calibration: 227 mV @ 12.42 Deg C
Reading After Calibration: 246 +/- 10 mV @ 12.42 Deg C

Comments:

AB 6-5-07 Pinto AAF ESI

MONITORING WELL DATA SHEET

WELL NUMBER: MW-05 FREQUENCY: NA SAMPLE NUMBER: RACWO5010706

DATE: 6-5-07 ARRIVAL TIME: 0810 DEPARTURE TIME: 0922

PURGE AMOUNT: 1.0 L PURGE START: 0840 PURGE STOP: 0901

WELL DEPTH: 63.60 WATER DEPTH: 58.53 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 0902 COC NUMBER:

PROJECT: RACW AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: AB, AB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
AB 6-5-07 ~~0845~~ 0855	026	9.89	47.5	5.78	-93	0.4
AB 6-5-07 ~~0848~~ 0858	025	9.88	47.4	5.68	-91	0.8
AB 6-5-07 ~~0851~~ 0901	024	9.88	47.4	5.65	-90	0.8
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Bail #3 TIME: 0921

COMMENTS AND OBSERVATIONS: Pump need to be lower in well

AB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 45°

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Bail

Rac AAF ESI

QB 6-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-17 FREQUENCY: NA SAMPLE NUMBER: RAGW17010706

DATE: 6-5-07 ARRIVAL TIME: 0925 DEPARTURE TIME: 0945

PURGE AMOUNT: 456 mL PURGE START: 0932 PURGE STOP: 0941

WELL DEPTH: 56.97 WATER DEPTH: 49.91 POINT DATUM: T/C

BAROMETER: 29.29 SAMPLE TIME: 0942 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: QB, AR

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
0935	110	10.15	46.7	6.26	-36	38.8
0938	109	9.07	47.3	6.31	-27	29.1
0941	107	7.89	47.4	6.32	-26	29.4
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Pump #3 TIME: 0943

COMMENTS AND OBSERVATIONS: NO Comments

QB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 50°

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Ra

6/5/07

AB 6-5-07

Rite NAF ESI

MONITORING WELL DATA SHEET

WELL NUMBER: MW-15 FREQUENCY: NA SAMPLE NUMBER: RAGW15010706

DATE: 6-5-07 ARRIVAL TIME: 0947 DEPARTURE TIME: 1002

PURGE AMOUNT: 900 mL AB ~~57.23~~ 6-5-06 PURGE START: 0951 PURGE STOP: 0959

WELL DEPTH: 57.23 WATER DEPTH: 50.61 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1000 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: AB, AB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
0953	166	10.05	48.0	6.25	21	57.2
0956	163	8.14	48.3	6.24	28	50.9
0959	167	8.12	48.5	6.23	29	49.6
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Bowl #3 TIME: 1002

COMMENTS AND OBSERVATIONS: No Comments

AB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 50°

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE

6/5/07

AB 6-5-07 Raco AAF ESI

MONITORING WELL DATA SHEET

WELL NUMBER: MW-06 FREQUENCY: NA SAMPLE NUMBER: RAGW06010706

DATE: 6-5-07 ARRIVAL TIME: 1007 DEPARTURE TIME: 1025

PURGE AMOUNT: 1646 mL 1.3 L 9364-07 PURGE START: 1008 PURGE STOP: 1021

WELL DEPTH: 59.10 WATER DEPTH: ~~59.95~~ ESI Fuller POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1022 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: AB, AB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1015	097	10.25	47.4	6.11	72	56.0
1018	095	9.59	47.9	5.98	82	49.3
1021	095	9.58	48.0	5.96	84	49.1
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Bowl #3 TIME: 1024

COMMENTS AND OBSERVATIONS: no Comments

AB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 50°

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason Ball

6/5/07

RACO MAF ESI

gB 6-5-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-07 FREQUENCY: N4 SAMPLE NUMBER: RAGW07010206

DATE: 6-5-07 ARRIVAL TIME: 1029 DEPARTURE TIME: 1041

PURGE AMOUNT: 500 mL PURGE START: ~~50.56~~ 1031 gB 6-5-07 PURGE STOP: 1039

WELL DEPTH: 59.01 WATER DEPTH: 50.95 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1040 COC NUMBER:

PROJECT: RACO CONTRACT NO./DELIVERY ORDER:

SAMPLED BY gB, gB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1033	217	11.47	49.7	6.28	77	109
1036	222	11.40	49.6	6.26	79	110
1039	223	11.39	49.5	6.25	80	111
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION Sample Round #3 TIME: 1048

COMMENTS AND OBSERVATIONS: No Comments

gB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 50°

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE [signature]

[signature] 6/5/07

Rac AAF ESI

1

MONITORING WELL DATA SHEET

WELL NUMBER: MW-18 FREQUENCY: NA SAMPLE NUMBER: RAGW18010706

DATE: 6-5-07 ARRIVAL TIME: 1045 DEPARTURE TIME: 1058

PURGE AMOUNT: 532 mL PURGE START: 1046 PURGE STOP: 1054

WELL DEPTH: 59.02 WATER DEPTH: 52.46 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1055 COC NUMBER:

PROJECT: RACO CONTRACT NO./DELIVERY ORDER:

SAMPLED BY:

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1048	064	10.74	48.1	6.25	86	74.7
1051	065	10.75	48.2	6.24	85	74.5
1054	065	10.70	48.5	6.23	84	74.3
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Bowl #3 TIME: 1057

COMMENTS AND OBSERVATIONS: No Comments

AB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 50°

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: [signature]

[signature] 6/5/07

Rafe AAF ESC

ab 6-5-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-22 FREQUENCY: NA SAMPLE NUMBER: RAGW22010706

DATE: 6-5-07 ARRIVAL TIME: 1059 DEPARTURE TIME: 1113

PURGE AMOUNT: 1.3L PURGE START: 1100 PURGE STOP: 1109

WELL DEPTH: 91.63 WATER DEPTH: 52.12 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1110 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: AB, JB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1103	277	11.43	50.2	7.28	67	1897
1106	278	8.10	50.3	7.30	66	1895
1109	279	8.09	50.4	7.31	64	1894
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sump Pump #3 TIME: 1112

COMMENTS AND OBSERVATIONS: No Comments. Water was very murky

AB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 50°

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason Butler

Rule 6/5/07

RACO AAF ESI

QB 6-5-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-08 FREQUENCY: NA SAMPLE NUMBER: RAGW08010706

DATE: 6-5-07 ARRIVAL TIME: 1115 DEPARTURE TIME: 1130

PURGE AMOUNT: 1023 ML PURGE START: 1117 PURGE STOP: 1126

WELL DEPTH: 75.65 WATER DEPTH: 49.58 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1127 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: QB.GB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1120	048	9.05	51.1	6.47	100	58.1
1123	047	8.60	51.5	6.22	110	51.1
1126	047	8.60	51.8	6.20	111	51.9
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Board #3 TIME: 1129

COMMENTS AND OBSERVATIONS: Feild Dup collected on this well Sample # for Dup is RAGW08020706

QB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 50°

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: [signature]

6/5/07

RACC AAF ESI

1

MONITORING WELL DATA SHEET

WELL NUMBER: MW-21 FREQUENCY: NA SAMPLE NUMBER: RAGW21010706

DATE: 6-5-07 ARRIVAL TIME: 1134 DEPARTURE TIME: 1150

PURGE AMOUNT: 1.5 L PURGE START: 1136 PURGE STOP: 1146

WELL DEPTH: 93.95 WATER DEPTH: 50.46 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1147 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: JB, JB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1140	130	7.04	52.5	7.13	87	124
1143	142	6.66	54.0	7.31	83	160
1146	143	6.59	54.1	7.33	81	JB 6-5-07 ~~197~~ 167
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Bowl #3 TIME: JB 6-5-07 ~~1139~~ 1149

COMMENTS AND OBSERVATIONS: No Comments

JB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 50°

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE [signature]

Rel 6/5/07

RACO AAF ESI

6-5-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-19 FREQUENCY: NA SAMPLE NUMBER: RAGW19010706

DATE: 6-5-07 ARRIVAL TIME: 1154 DEPARTURE TIME: 1209

PURGE AMOUNT: 1.4L PURGE START: 1156 PURGE STOP: 1202

WELL DEPTH: 93.93 WATER DEPTH: 52.43 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1203 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: AB, AB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1156	276	7.11	50.0	7.43	79	105
1159	281	6.13	50.1	7.48	77	104
1202	281	6.11	50.1	7.46	79	106
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Bowl #3 TIME: 1208

COMMENTS AND OBSERVATIONS: Matrix Spike & Matrix Spike Dup collected on this well

AB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 50°

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason Bauer

Rcd 11/8/07

RACO AAF ESI

MONITORING WELL DATA SHEET

WELL NUMBER: MW-14
FREQUENCY: NA
SAMPLE NUMBER: RAGW14010706
DATE: 6-5-07
ARRIVAL TIME: 1210
DEPARTURE TIME: 1227
PURGE AMOUNT: 600 mL
PURGE START: 1213
PURGE STOP: 1221
WELL DEPTH: 58.87
WATER DEPTH: 54.54
POINT DATUM: TIC
BAROMETER: 29.29
SAMPLE TIME: 1222
COC NUMBER:
PROJECT: RACO AAF
CONTRACT NO./DELIVERY ORDER:
SAMPLED BY: AB, AB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1215	024	8.52	49.7	7.54	74	111
1218	022	6.54	49.5	7.14	91	112
1221	022	6.53	50.0	7.10	98	111
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Bowl #3
TIME: 1226

COMMENTS AND OBSERVATIONS: no comments

AB 6-5-07

FIELD CONDITIONS: NORMAL
TEMPERATURE: 52°

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Butler

Pull 6/5/07

RACO AAF ESI

AB 6-5-07

MONITORING WELL DATA SHEET

WELL NUMBER: RG02 FREQUENCY: NA SAMPLE NUMBER: RAGW02010706

DATE: 6-5-07 ARRIVAL TIME: 1248 DEPARTURE TIME:

PURGE AMOUNT: 550 mL PURGE START: 1253 PURGE STOP: 1255

WELL DEPTH: 52.70 WATER DEPTH: 49.88 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1256 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: QB, QB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1255	861	6.64	57.0	7.06	90	252
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Board #3 TIME:

COMMENTS AND OBSERVATIONS: Due to slow recharge & low water level only one field reading took.

QB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 55°

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason Burt

6/5/07

AB 6-5-07 RACO AAF ESI

SURFACE WATER DATA SHEET

LOCATION: RACO AAF Sink Hole FREQUENCY: NA DATE: 6-5-07

ARRIVAL TIME: 1313 DEPARTURE TIME: 1320 SAMPLE TIME: 1310

SAMPLE NUMBER(S): RASW01010706

COC NUMBER(S):

PROJECT: RACO AAF CONTRACT NO/ DELIVERY ORDER:

SAMPLED BY: AB, AB, TC

FIELD PARAMETERS

TIME	COND (µmhos/cm)	DO (mg/L)	TEMP (°C)	pH (su)	ORP (mv)	TURB (NTU)	FLOW RATE (MGD)
1309	612	10.95	48.7	6.99	87	199	NA

STREAM DISCHARGE CALCULATION

Distance from edge of stream (ft)	Depth (ft)	Flow Velocity (ft/s)
NA	NA	NA
↓	↓	↓

COMMENTS AND OBSERVATIONS: Sample taken from sink hole

AB 6-5-07

Size: 10' deep, 95' down, 3' diameter

Analyticals to collect:

FIELD CONDITIONS: NORMAL TEMPERATURE: 55°

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason B.

Pull 6/5/07

RACO AAF RI

AB 6-5-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-20 FREQUENCY: NA SAMPLE NUMBER: RAGW20010706

DATE: 6-5-07 ARRIVAL TIME: 1229 DEPARTURE TIME: 1246

PURGE AMOUNT: 1.2 L PURGE START: 1232 PURGE STOP: 1241

WELL DEPTH: 89.00 WATER DEPTH: 54.72 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: ~~54.72~~ 1242 AB 6-5-07 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: AB, AB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1235	131	7.78	47.3	7.37	92	2000
1238	131	7.42	47.6	7.42	91	2000
1241	131	7.30	47.8	7.51	89	2000
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Board #3 TIME: 1245

COMMENTS AND OBSERVATIONS: no comments

AB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 55°

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Banks

6/5/07

RACO AAF ESI

a3
6-4-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-09
FREQUENCY: NA
SAMPLE NUMBER: RAGW09010706
DATE: 6-5-07
ARRIVAL TIME: 1335
DEPARTURE TIME: 1355
PURGE AMOUNT: 500mL
PURGE START: 1338
PURGE STOP: 1345
WELL DEPTH: 47.33
WATER DEPTH: 43.02
POINT DATUM: TIC
BAROMETER: 29.29
SAMPLE TIME: 1346
COC NUMBER:
PROJECT: RACO AAF
CONTRACT NO./DELIVERY ORDER:
SAMPLED BY: JB. JB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1345	060	6.88	56.7	7.63	60	81.4
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Board #3
TIME: 1353

COMMENTS AND OBSERVATIONS: Pump need to be lower depth given prev. inconnect. Only one feild reading took due to insufficent water
JB 6-5-07

FIELD CONDITIONS: NORMAL
TEMPERATURE: 55°

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Bach

Rvd 6/5/07

RACO AAF ESI

AB 6-5-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-10 FREQUENCY: NA SAMPLE NUMBER: RAGW 10010706

DATE: 6-5-07 ARRIVAL TIME: 1402 DEPARTURE TIME: 1418

PURGE AMOUNT: 550 mL PURGE START: 1408 PURGE STOP: 1410

WELL DEPTH: 44.82 WATER DEPTH: 41.92 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1411 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: AB, AB, TC

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1410	082	11.03	51.3	7.49	88	137
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Bowl #3 TIME: 1416

COMMENTS AND OBSERVATIONS: Only one feild reading took due to insuffic+ water. Feild Dup also collected on this well.

AB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 55°

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason Burks

11/5/07

RACO AAF GSI

1

MONITORING WELL DATA SHEET

WELL NUMBER: MW-12 FREQUENCY: NA SAMPLE NUMBER: RAGW12010706

DATE: 6-5-07 ARRIVAL TIME: 1425 DEPARTURE TIME: 1430

PURGE AMOUNT: 550 mL PURGE START: 1427 PURGE STOP: 1434

WELL DEPTH: 13.13 WATER DEPTH: ~~38.80~~ 38.36 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1435 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: GB, GB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1428	020	8.51	47.3	6.70	101	136
1431	020	8.77	47.4	6.55	106	135
1434	020	8.78	47.4	6.56	107	135
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Bowl #3 TIME: 1439

COMMENTS AND OBSERVATIONS: No Comments

GB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 550

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE

6/5/07

RACO AAF CSI

1

MONITORING WELL DATA SHEET

WELL NUMBER: MW-16 FREQUENCY: NA SAMPLE NUMBER: RAGW16010706

DATE: 6-5-07 ARRIVAL TIME: 1445 DEPARTURE TIME: 1459

PURGE AMOUNT: 600 mL PURGE START: 1447 PURGE STOP: 1455

WELL DEPTH: 44.42 WATER DEPTH: 38.80 POINT DATUM: TIC

BAROMETER: 29.29 SAMPLE TIME: 1456 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: JB, JB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1449	023	7.36	52.4	6.46	113	123
1452	023	7.36	52.5	6.42	113	122
1455	022	7.31	52.6	6.41	119	122
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Bowl #3 TIME: 1458

COMMENTS AND OBSERVATIONS: No Comments

JB 6-5-07

FIELD CONDITIONS: NORMAL TEMPERATURE: 55°

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason

6/5/07

RACO AAF ESI

QA 6-5-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-11
FREQUENCY: NA
SAMPLE NUMBER: RAGW01010706
DATE: 6-5-07
ARRIVAL TIME: 1500
DEPARTURE TIME: 1520
PURGE AMOUNT: 550 mL
PURGE START: 1503
PURGE STOP: 1511
WELL DEPTH: 45.58
WATER DEPTH: 41.30
POINT DATUM: TIC
BAROMETER: 29.29
SAMPLE TIME: 1512
COC NUMBER:
PROJECT: RACO AAF
CONTRACT NO./DELIVERY ORDER:
SAMPLED BY: QB, QB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1505	019	7.14	49.2	6.61	125	156
1508	019	7.06	49.3	6.61	125	159
1511	019	7.03	49.4	6.60	127	159
NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓

EQUIPMENT DECON

DESCRIPTION: Sample Board #3
TIME: 1318

COMMENTS AND OBSERVATIONS: No Comments

QB 6-5-07

FIELD CONDITIONS: NORMAL
TEMPERATURE: 55°

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Bu

RWL 6/5/07

RACO AAF ESI

1

8/2

QUANTA DAILY CALIBRATION

Hydrolab # GEO-461-1
GEO-461-2
GEO-461-3

By TC JH BG MC JB VM RT JB
Date: 8-2-07

pH CALIBRATION

Buffer +/- .1 SU	Lot #	Exp. Date	Vendor	Time	Temp (Celsius)	pH	Adj. To
pH 4	4520	8-08	F	1100	24.0	4.03	4.00
pH 7	063709	7-08	F	1058	24.1	7.04	7.00
pH 10	060752	2-05	F	1102	23.8	10.01	10.00

D.O. AIR CALIBRATION

Solution Temp(C): ~~29.99~~ 24.3 ~~8-2-07~~ Local B.P.: 29.99

% Saturation: 100%

% Saturation (fixed): 100%

DO mg/l Reading (+/- 0.2 mg/l) 8.28 @ 24.3 Deg Celsius

Does reading meet DO Saturation Values acceptance criteria? ✓ Yes ____ No
If No, Recalibrate or check Operations Manual for maintenance.

CONDUCTIVITY CALIBRATION

Standard Value:
1412 (umhos) 1.412 (mS) Lot # 1704195 Exp: 3-08 Manufacturer: Ricca

Temperature (C): ____ Conductivity(+/- 20 umhos): ____ Adjusted To: ____

TURBIDITY CALIBRATION PERFORMANCE CHECK

4-Beam Turbidity Quick-Cal Cube QCC#:81181

GEO 461-1=75.0 +/- 20%
GEO 461-2=77.9 +/- 20%
GEO 461-3=77.0 +/- 20%

Reading 77.3 NTU

✓ Reading is within acceptance criteria of the Quick-Cal Cube for the instrument to be used.

____ Reading is not within acceptance criteria of the Quick-Cal Cube for the instrument to be used. If reading is not within the Quick-Cal Cube acceptance criteria, perform primary calibration according to operational manual.

ORP Calibration

ZoBell Solution:
Lot #: 1703821 Expiration Date: 11-07

ZoBell Solution's ORP Value: 237 +/- 10 mV @ 20 Deg C

Reading Prior to Calibration: 247 mV @ 24 Deg C
Reading After Calibration: 231 +/- 10 mV @ 24 Deg C

Comments:

8/7/07

TRACO AAF ESI

97
8.7.07

MONITORING WELL DATA SHEET

WELL NUMBER: MW12 FREQUENCY: _____ SAMPLE NUMBER: RAGW12010708

DATE: 8/7/07 ARRIVAL TIME: 0900 DEPARTURE TIME: 0951

PURGE AMOUNT: 550 mL PURGE START: 0930 PURGE STOP: 0940

WELL DEPTH: 43.13 WATER DEPTH: 38.90 POINT DATUM: TOC

BAROMETER: - SAMPLE TIME: 0940 COC NUMBER: _____

PROJECT: TRACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: GB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
0930	019	3.72	49.1	5.85	338	103
0935	020	3.57	48.6	5.71	344	97.0
0940	020	3.90	48.1	5.73	342	95.3

EQUIPMENT DECON

DESCRIPTION: N/A TIME: _____

COMMENTS AND OBSERVATIONS: No Comments

FIELD CONDITIONS: Normal TEMPERATURE: 70°

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: [signature]

[signature] 8/7/07

RACO MAF ESI

8/7/07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-14 FREQUENCY: _____ SAMPLE NUMBER: RAEW1601070 8

DATE: 8/7/07 ARRIVAL TIME: 0955 DEPARTURE TIME: 1010

PURGE AMOUNT: 600 mL PURGE START: 0959 PURGE STOP: 1006

WELL DEPTH: ~~45.58~~ 44.32 WATER DEPTH: 38.44 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1007 COC NUMBER: _____

PROJECT: RACO MAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: JB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1000	021	3.33	49.7	6.03	346	119
1003	020	3.55	49.4	5.92	349	112
1006	020	3.67	49.3	5.89	348	106

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: No Comments

FIELD CONDITIONS: NORMAL TEMPERATURE: 70F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: [signature]

[signature] 8/7/07

RACO AAF ESI

8-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-11 FREQUENCY: _____ SAMPLE NUMBER: RAGW11010708

DATE: 8-7-06 ARRIVAL TIME: 1012 DEPARTURE TIME: 1028

PURGE AMOUNT: 550 mL PURGE START: 1014 PURGE STOP: 1022

WELL DEPTH: 45.58 WATER DEPTH: 40.67 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1023 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: GA

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1016	018	3.35	49.2	4.18	345	106
1019	017	3.55	46.4	5.93	349	107
1022	017	3.59	46.3	5.86	351	103

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: no Comments

FIELD CONDITIONS: NORMAL TEMPERATURE: 70 F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason Banks

8/7/07

AB 8.7.07 RACO AAF ESI

MONITORING WELL DATA SHEET

WELL NUMBER: MW-10 FREQUENCY: SAMPLE NUMBER: RAGW10010708

DATE: 8-7-07 ARRIVAL TIME: 1030 DEPARTURE TIME: 1038

PURGE AMOUNT: 550 mL PURGE START: 1032 PURGE STOP: 1033

WELL DEPTH: 44.82 WATER DEPTH: NA POINT DATUM: TIC

BAROMETER: SAMPLE TIME: 1034 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: AB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1033	01	323	60.6	6.36	353	31.5

EQUIPMENT DECON

DESCRIPTION: TIME:

COMMENTS AND OBSERVATIONS: ~~insuff~~ water below top of pump

FIELD CONDITIONS: NORMAL TEMPERATURE: 70° F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason Bak

8/7/07

RACO AAF ESI

93
8-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-09 FREQUENCY: SAMPLE NUMBER: RAGW09010708

DATE: 8-7-07 ARRIVAL TIME: 1042 DEPARTURE TIME: 1110

PURGE AMOUNT: 500mL PURGE START: 1105 PURGE STOP: 1107

WELL DEPTH: 47.33 WATER DEPTH: NA POINT DATUM: TIC

BAROMETER: SAMPLE TIME: 1108 COC NUMBER:

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER:

SAMPLED BY: GB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1107	059	2.62	66.0	7.21	345	96.6

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: Lower pump but only gained about 3"

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason R

8/7/07

RACO AAF ESI

8-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-05 FREQUENCY: _____ SAMPLE NUMBER: RAGW05010708

DATE: 8-7-07 ARRIVAL TIME: 1114 DEPARTURE TIME: 1120

PURGE AMOUNT: 600mL PURGE START: 1116 PURGE STOP: 1117

WELL DEPTH: 63.60 WATER DEPTH: NA POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1118 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: JB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1117	023	2.52	66.0	7.25	339	80.1

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: Water Below top of pump

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason Banks

8/7/07

RACO AAF ESI

AB 9-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-17 FREQUENCY: _____ SAMPLE NUMBER: RAGW17DL0708

DATE: 8-7-07 ARRIVAL TIME: 1126 DEPARTURE TIME: 1135

PURGE AMOUNT: 456mL PURGE START: 1127 PURGE STOP: 1133

WELL DEPTH: 56.97 WATER DEPTH: 49.60 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1134 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: AB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1128	113	4.12	50.6	6.63	363	110
1131	112	3.53	48.1	6.69	363	111
1133	104	3.62	47.6	6.73	364	107

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: No Comments

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason Burk

Rel 8/7/07

RACO AAF ESI

QB 8-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-07 FREQUENCY: _____ SAMPLE NUMBER: RAGW07010708

DATE: 8-7-07 ARRIVAL TIME: 1136 DEPARTURE TIME: 1150

PURGE AMOUNT: 500mL PURGE START: 1138 PURGE STOP: 1146

WELL DEPTH: 59.01 WATER DEPTH: 50.56 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1147 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: QB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1140	217	3.49	51.9	6.93	372	123
1143	216	3.69	50.8	6.64	373	121
1146	217	3.68	50.9	6.64	374	119

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: NO comments

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Bak

Rwl 8/7/07

RAO AAF ESI

8-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-15 FREQUENCY: _____ SAMPLE NUMBER: RAGW15010708

DATE: 8-7-07 ARRIVAL TIME: 1152 DEPARTURE TIME: 1206

PURGE AMOUNT: 906mL PURGE START: 1154 PURGE STOP: 1202

WELL DEPTH: 57.23 WATER DEPTH: 50.16 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1203 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: QB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1156	139	3.56	50.8	6.97	361	105
1159	142	3.57	52.4	6.66	363	106
1202	142	3.57	52.8	6.65	364	106

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: NO Comments

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason R

8/7/07

RACO AAF ESI

8-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW04 FREQUENCY: _____ SAMPLE NUMBER: RAGW04010708

DATE: 8-7-07 ARRIVAL TIME: 1208 DEPARTURE TIME: 1221

PURGE AMOUNT: 1646mL PURGE START: 1210 PURGE STOP: 1218

WELL DEPTH: 59.10 WATER DEPTH: 52.22 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1219 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: QB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1212	094	3.80	50.8	6.99	360	109
1215	086	3.81	49.3	6.51	362	110
1218	085	3.81	49.1	6.48	363	111

EQUIPMENT DECON

DESCRIPTION: NA TIME NA

COMMENTS AND OBSERVATIONS: No Comments

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason Bul

8/7/07

RACO AAF ESI

QB 8-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: RG-02 FREQUENCY: _____ SAMPLE NUMBER: RAGW020000708

DATE: 8-7-06 ARRIVAL TIME: 1222 DEPARTURE TIME: 1227

PURGE AMOUNT: 550 mL PURGE START: 1224 PURGE STOP: 1225

WELL DEPTH: 52.70 WATER DEPTH: NA POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1226 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: QB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1225	054	3.09	54.8	6.77	353	126

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: Water level below top of pump

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY (SUNNY) SNOWY

SIGNATURE: Susan Pak

Rcd 8/7/07

RACO AAF ESI

AB 8-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-22 FREQUENCY: _____ SAMPLE NUMBER: RAGW22010705

DATE: 8-7-07 ARRIVAL TIME: 1230 DEPARTURE TIME: 1243

PURGE AMOUNT: 1.32 PURGE START: 1232 PURGE STOP: 1240

WELL DEPTH: 91.63 WATER DEPTH: 51.70 POINT DATUM: TOC

BAROMETER: _____ SAMPLE TIME: 1241 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: AB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1234	267	2.99	55.7	7.57	361	2000
1237	296	3.83	53.5	7.65	361	2000
1240	295	3.74	53.5	7.66	361	2000

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: No Comments

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE Jason Bowl

Rwl 8/7/07

RACO AAF ESI

QB 8-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-18 FREQUENCY: _____ SAMPLE NUMBER: RAGW018010708

DATE: 8-7-07 ARRIVAL TIME: 1244 DEPARTURE TIME: 1256

PURGE AMOUNT: 532mL PURGE START: 1245 PURGE STOP: 1252

WELL DEPTH: 59.02 WATER DEPTH: 51.92 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1253 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: QB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1246	065	3.62	54.5	7.69	348	147
1249	064	3.88	53.8	7.34	351	146
1252	064	3.91	53.6	7.32	351	145

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: No Comments Matrix spike + matrix spike dup collected on this well

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Bu

8/7/07

RACO AAF ESI

93
8.7.07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-08 FREQUENCY: _____ SAMPLE NUMBER: RACW08010708

DATE: 8-7-06 ARRIVAL TIME: 1258 DEPARTURE TIME: 1315

PURGE AMOUNT: 1023 ml PURGE START: 1259 PURGE STOP: 1308

WELL DEPTH: 78.63 WATER DEPTH: 49.92 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1309 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: 93

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1302	046	3.14	59.0	6.98	347	146
1305	048	3.22	58.3	6.38	351	137
1308	045	3.26	57.8	6.28	361	133

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: Feild Dup collected on this well

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Bunter

8/7/07

PGAO AAF ESI

ABT 8-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-21 FREQUENCY: _____ SAMPLE NUMBER: RAGW21010708

DATE: 8-7-07 ARRIVAL TIME: 1316 DEPARTURE TIME: 1330

PURGE AMOUNT: 1.5L PURGE START: 1317 PURGE STOP: 1325

WELL DEPTH: 93.95 WATER DEPTH: 50.12 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1326 COC NUMBER: _____

PROJECT: _____ CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: _____

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1319	147	2.80	56.4	7.10	359	257
1322	144	3.45	54.3	7.28	360	232
1325	144	3.40	54.1	7.27	361	222

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: no comments

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Burke

Pull 8/7/07

RACO AAF ESI

8-7-07 JB

MONITORING WELL DATA SHEET

WELL NUMBER: MW-14 FREQUENCY: _____ SAMPLE NUMBER: RAGW14010708

DATE: 8-7-07 ARRIVAL TIME: 1331 DEPARTURE TIME: 1345

PURGE AMOUNT: 600mL PURGE START: 1332 PURGE STOP: 1341

WELL DEPTH: 58.87 WATER DEPTH: 54.21 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1342 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: JB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1335	027	3.14	55.4	8.01	340	106
1338	022	3.63	53.1	7.74	342	112
1341	022	3.64	52.8	7.70	342	113

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: no comments

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Banks

8/7/07

RACO AAF ESI

1

MONITORING WELL DATA SHEET

WELL NUMBER: MW-19 FREQUENCY: _____ SAMPLE NUMBER: RAGW19010708

DATE: 3/7/07 ARRIVAL TIME: 1346 DEPARTURE TIME: 1359

PURGE AMOUNT: 1.4L PURGE START: 1347 PURGE STOP: 1355

WELL DEPTH: 93.93 WATER DEPTH: 52.09 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1356 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: QB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1349	316	3.69	52.9	7.78	363	142
1352	309	3.54	51.3	7.67	364	194
1355	312	3.51	50.9	7.61	365	193

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: NO Comments Field Dup collected on this well

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: Jason Bu

Well 3/7/07

RACO AAF ESI

QB 8-7-07

MONITORING WELL DATA SHEET

WELL NUMBER: MW-20 FREQUENCY: _____ SAMPLE NUMBER: RAGW20010708

DATE: 8-7-07 ARRIVAL TIME: 1402 DEPARTURE TIME: 1420

PURGE AMOUNT: 1.2L PURGE START: 1403 PURGE STOP: 1411

WELL DEPTH: 99.00 WATER DEPTH: 54.38 POINT DATUM: TIC

BAROMETER: _____ SAMPLE TIME: 1412 COC NUMBER: _____

PROJECT: RACO AAF CONTRACT NO./DELIVERY ORDER: _____

SAMPLED BY: QB

FIELD PARAMETERS

TIME	COND (µmhos/cm)	D.O. (mg/L)	TEMP (°C)	PH (su)	ORP (mv)	TURB (NTU)
1405	128	3.63	54.2	8.01	351	1526
1408	120	4.02	53.8	7.90	354	1013
1411	120	4.04	53.2	7.90	354	1013

EQUIPMENT DECON

DESCRIPTION: NA TIME: NA

COMMENTS AND OBSERVATIONS: NO Comments

FIELD CONDITIONS: NORMAL TEMPERATURE: 70°F

WEATHER CONDITIONS: (circle one) CLOUDY RAINY SUNNY SNOWY

SIGNATURE: [signature]

8/7/07

RADIOLOGICAL SURVEY REPORT
Gamma Walkover Survey

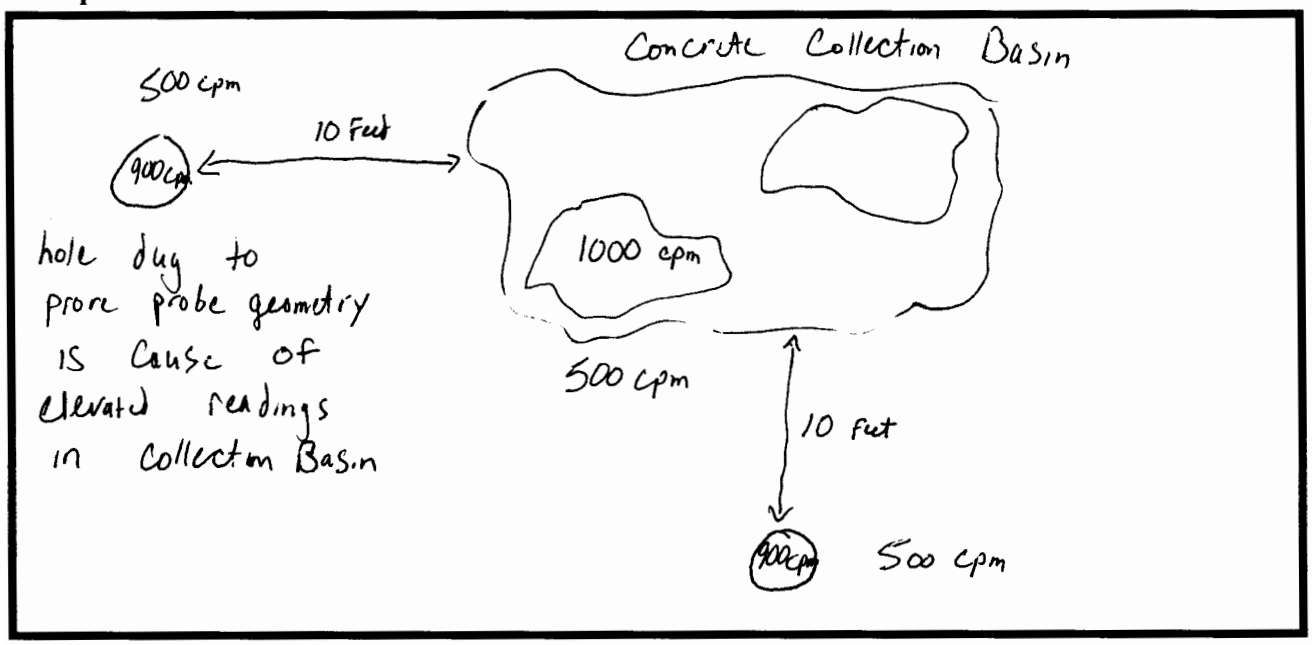
Survey #:

Survey Location: Raco, BOMARC Site		
Date: 6/5/2007	Time: 0930	HSWP: N/A
Purpose of Survey: Confirm to MDEQ absence of any radioactive contam		

Instruments:

Inst. Type	Inst. #	GPS Pack #	Meter	Detector	Meter	Detector	Bkgd
			S/N	S/N	Cal Due	Cal Due	(cpm)
Ludlum 2221/44-10	N/A	N/A	228813	249948	4/1/08	4/1/08	500
Ludlum 2221/44-10							

Map:



Remarks:

Survey performed in presence of MDEQ Rep; & GCO Field Manager, Todd Calhoon.

Technicians: W. Clark Ever
Name

Name

Name

Name

Reviewed by: CHP JUN 11 2007
Name

Date

INSTRUMENTATION QC CHECK LOG

METER : 44-10

DATE (MO/YR): June 2007

Source		Acceptance Criteria							
Type	Cs-137	Bkgrd. QC (cpm) range		Source QC (cpm) range			Model	Number	Cal. Due
Number	5311-04	947 to 1074		67,187 to 100,780		Meter	228813	2221	4/1/08
						Detector	249948	44-10	4/1/08
Date	Time	Pre-use Bkg cpm	Post Bkg cpm[1]	Pre-use Source cpm	Post Source cpm[1]	Bat Check	QC Check	HPT Initials	
6/3/07	0620	1020	N/A	86323	N/A	SAT	SAT	WCE	

[1] Gamma scan Instruments used for confirmation or verification surveys require a post check-in.

Reviewed By : _____ (RPM/Designee)

Date : JUN 11 2007

44-10

Initial Instrument Check In

Meter Number:	22813	Detector Number:	249948
Meter Model:	2221	Detector Model:	44-10
Cal. Due:	4/1/08	Cal. Due:	4/1/08

ALPHA	Source Type:		Threshold:		
ALPHA	Source #:		High Voltage:		
ALPHA	Source Activity:				
ALPHA	Source count time:		Background count time:		(min)
ALPHA	**Source GCPM**	**BKG CPM**	Average Bkg. (CPM):		
ALPHA			Average Source (GCPM):		
ALPHA			Average Net Source (NCPM):		
ALPHA			Source Range (GCPM):		to
ALPHA			Background Range (CPM):		to
ALPHA			Determined Efficiency:		
ALPHA					
ALPHA			20% of Bkg.		
ALPHA			1 Standard Deviation of Bkg.		
ALPHA			3 Standard Deviations of Bkg.		
ALPHA					

A

N

Beta / Gamma (circle one)

BETA	Source Type:	Cs-137	Threshold:	100 mV	
BETA	Source #:	5311-04	High Voltage:	1000 V	
BETA	Source Activity:	1.0 uCi			
BETA	Source count time:	1	Background count time:	1	(min)
BETA	**Source GCPM**	**BKG CPM**	Average Bkg. (CPM):	1,011	
BETA	85,758	1027	Average Source (GCPM):	83,983	
BETA	83,009	1003	Average Net Source (NCPM):	N/A	
BETA	84,440	1032	Source Range (GCPM):	67,187	to 100780
BETA	84,020	1012	Background Range (CPM):	947	to 1074
BETA	84,689	979	Determined Efficiency:	N/A	
BETA					
BETA		A	20% of Bkg.	202	
BETA			1 Standard Deviation of Bkg.	N/A	
BETA	N		3 Standard Deviations of Bkg.	N/A	
BETA					

Performed By: W. Mark Em Date: 6/4/07

Reviewed By: [signature] Date: JUN 1 1 2007
(RPM / Asst. RPM)

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER SAIC ORDER NO. 273600

Mfg. Ludlum Measurements, Inc. Model 2221 Serial No. 228813

Mfg. Ludlum Measurements, Inc. Model 44-10 Serial No. PR 249948

Cal. Date 1-Apr-07 Cal Due Date 1-Apr-08 Cal. Interval 1 Year Meterface 202-159

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 33 % Alt 698.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set Comments V Input Sens. Comment mV Det. Oper. Comments V at Comment mV Threshold Dial Ratio 10 = 10 mV

☑ HV Readout (2 points) Ref./Inst. 500 / 501 V Ref./Inst. 2000 / 2003 V

COMMENTS:

	Peak settings	Gross Counts
High Voltage:	697 v	1000 volts
Threshold dial:	642	100(10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
Resolution for Cs137:	≈ 8.76 %	n/a

Model 2221 currently set Peaking.

High voltage set with detector connected.
Firmware#; 261072

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1K	400kcpm		400
X 1K	100kcpm		100
X 100	40kcpm		400
X 100	10kcpm		100
X 10	4kcpm		400
X 10	1kcpm		100
X 1	400cpm		400
X 1	100cpm		100

*Uncertainty within ± 10% C.F. within ± 20% ALL **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm		40033 (0)	Log Scale	500kcpm		475k
	40kcpm		4003 (0)		50kcpm		50k
	4kcpm		400 (0)		5kcpm		5k
	400cpm		40 (0)		500cpm		500
	40cpm		4 (0)		50cpm		52

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: ☐ S-394/1122 ☐ 1131 ☐ 781
Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ☐ Beta S/N ☑ Other Am241~1.66μCi

☑ m 500 S/N 38120 ☐ Oscilloscope S/N ☑ Multimeter S/N 84260131

Calibrated By: Lemin Ortega Date 1-Apr-07

Reviewed By: Diana DeRosa Date 2 apr 07

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.

AC Inst. ☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR 249948

Customer SAIC Order #. 273600

Counter 2221 Serial No. 228813 Counter Input Sensitivity 10 mV

Count Time 6 seconds Distance Source to Detector ≈ 2 cm

Other

High Voltage	Background	Isotope Am 241 Size ≈ 1.66 uCi	Isotope Size	Isotope Size	Isotope Size
800	592	12709			
850	521	14390			
900	547	15167			
950	553	15126			
✓ 1000	582	15374			
1050	535	15484			
1100	569	15655			
1150	569	15648			

Signature Lemon Ortega Date 1-Apr-07

FORM C4A 04/09/2003

INSTRUMENTATION QC CHECK LOG

METER : 43-89 DATE (MO/YR) : June 2007

Meter		Acceptance Criteria				Alpha			
Number	Cal. Due	Bkgrd. QC (cpm) range		Source QC (ncpm) range		Source Type	Source Number	Inst. Efficiency	Inst. Avg. Bkgrd.
202457	5/30/08	Alpha	Beta	Alpha	Beta	Th-230	5312-04	36.8%	0.2
Detector		0.0 to 0.3	278 to 294	2752 to 4129	1985 to 2977	Beta			
Number	Cal. Due					Source Type	Source Number	Inst. Efficiency	Inst. Avg. Bkgrd.
212726	5/30/08					Sr-90	5313-04	39.8%	286

Date	Time	Bkgrd. QC (cpm)		Source QC (ncpm) range		Bat. Check	QC[1]	HPT	Comment
		Alpha	Beta	Alpha	Beta	Sat/Unsat	Sat/Unsat	Initial	
6/5/07	0620	0.2	285	3427	2952	SAT	SAT	WXS	

A

N

[1] An unsatisfactory QC check requires recording the result in the comment column and repeating the evaluation. Tag the instrument out of service and notify the HP Supervisor upon failing the QC check two times in succession.

Reviewed By : _____ (RPM/Designee) Date : JUN 11 2007

43-89

SAIC ST. LOUIS

HP-30 Rev. 3
Attachment 2

Initial Instrument Check In

Meter Number:	202457	Detector Number:	212726
Meter Model:	2360	Detector Model:	43-89
Cal. Due:	5/30/08	Cal. Due:	5/30/08

ALPHA	Source Type:	Th-230	Threshold:	120 mV
ALPHA	Source #:	5312-04	High Voltage:	740 V
ALPHA	Source Activity:	9540		
ALPHA	Source count time:	1	Background count time:	10 (min)
ALPHA	**Source GCPM**	**BKG CPM**	Average Bkg. (CPM):	0.2
ALPHA	3547	0.2	Average Source (GCPM):	3441
ALPHA	3409	0.2	Average Net Source (NCPM):	NA
ALPHA	3473	0.2	Source Range (GCPM):	2752 to 4129
ALPHA	3399	0.1	Background Range (CPM):	0.0 to 0.3
ALPHA	3386	0.1	Determined Efficiency:	36.8%
ALPHA				
ALPHA			20% of Bkg.	0.0
ALPHA			1 Standard Deviation of Bkg.	NA
ALPHA			3 Standard Deviations of Bkg.	NA
ALPHA				

Beta / Gamma (circle one)

BETA	Source Type:	Sr-90	Threshold:	3.5 mV
BETA	Source #:	5313-04	High Voltage:	740 V
BETA	Source Activity:	5,520		
BETA	Source count time:	1	Background count time:	10 (min)
BETA	**Source GCPM**	**BKG CPM**	Average Bkg. (CPM):	286
BETA	2441	283	Average Source (GCPM):	2481
BETA	2492	284	Average Net Source (NCPM):	NA
BETA	2440	287	Source Range (GCPM):	1985 to 2977
BETA	2497	289	Background Range (CPM):	278 to 294
BETA	2536	288	Determined Efficiency:	39.8%
BETA				
BETA			20% of Bkg.	57
BETA			1 Standard Deviation of Bkg.	N/A
BETA			3 Standard Deviations of Bkg.	N/A
BETA				

Performed By: W. Clark Ein Date: 6/4/07

Reviewed By: [signature] Date: JUN 11 2007
(RPM / Asst. RPM)

2360/2224/4 Scaler/Ratemeter Calibration Report

Date Calibrated: 05/31/2007 1:21:26 PM
Technician: B. French
Customer: SAIC
Order Number: SAIC20070531-001
Temperature (F): 76 Humidity (%): 30 Altitude (asl): 660 Barametric Pressure ("Hg): 29.15

Repair Instrument

Serial Number: 202457 Manufacturer: Ludlum Model: 2360 Meterface: 202-855
Received: Within 10%
Last Calibrated: 4/8/2005 Calibration Interval: 1 yr. Next Calibration Due: 5/30/2008

- [x] Mechanical OK
- [x] Meter Zeroed
- [x] Battery Ck. - Min. Volt.
- [x] Input Sens. Linearity
- [x] F/S Resp. OK
- [x] Reset OK
- [x] Geotropism
- [x] Window Operation
- [x] Audio OK
- [ ] Alarm Setting OK
- [ ] Background Subtract
- [x] Voltage Set — 740 V at (see comments)mV — Det. Op. 740 V at (see comments)mV — Threshold Dial ratio N/A
- [x] HV readout — **Ref. 1** 500Volts **Inst. 1** 500Volts — **Ref. 2** 2003Volts **Inst. 2** 2000Volts
- [x] Calibrated in accordance with ANSI N323-1997 and the manufacturer's procedure

CTV* Analog Reading

Multiplier	Ref. Cal Point	Inst. As Found	Inst. As Left
X 1000	400 K cpm	400 K cpm	400 K cpm
X 1000	100 K cpm	100 K cpm	100 K cpm
X 100	40 K cpm	40 K cpm	40 K cpm
X 100	10 K cpm	10 K cpm	10 K cpm
X 10	4 K cpm	4 K cpm	4 K cpm
X 10	1 K cpm	1 K cpm	1 K cpm
X 1	400 cpm	400 cpm	400 cpm
X 1	100 cpm	100 cpm	100 cpm

- [x] Multimeter ser. # 93470436
- [ ] Oscilloscope ser. #
- [x] m500 ser. # 201462
- [ ] Other ser. #

CTV* Digital

Reference Pt.	Inst. as Found	Inst. as Left
400 K cpm	40019 (0) cpm	40002 (0) cpm
40 K cpm	4004 (0) cpm	4000 (0) cpm
4 K cpm	401 (0) cpm	400 (0) cpm
400 cpm	40 (0) cpm	40 (0) cpm
40 cpm	4 (0) cpm	4 (0) cpm

Comments

For input sensitivities, see detector calibration form

* Conventionally True Value ** Uncertainty within +/- 10% All range(s) calibrated electronically

Performed By: [signature] Date: 5/31/07
Reviewed By [signature] Date: 5-31-07

43-89 Alpha Beta Calibration Report

Date Calibrated: 05/31/2007 1:24:31 PM

Technician: B. French Customer: SAIC Order Number: SAIC20070531-002

Repair Instrument

Serial Number 212726 Manufacturer: Ludlum Model: 43-89 Last Calibrated: 4/8/2005

Reason for recalibration: Due for Calibration

Calibration Instrument

Light Leak Test: Sat

Serial Number: 202457 Inst. Type: 2360 Calibration Due: 5/30/2008

Calibration Sources

4π	Alpha Source I	HB562	Isotope:	Th-230	Current Activity	25618.28 dpm	Assay Date 2/17/2000
	Beta Source ID:	HB 560	Isotope:	Sr-90	Current Activity	120824.23 dpm	Assay Date 2/17/2000
2π	Alpha Source I	HB562	Isotope:	Th-230	Current Activity	12419.17	Assay Date 2/17/2000
	Beta Source ID:	HB 560	Isotope:	Sr-90	Current Activity	78535.75	Assay Date 2/17/2000

Alpha as Found	Beta as Found	Alpha as Left 5/31/07	Beta as Left
Background 10 min. counts	Background 1 min. cou	Background 10 min. counts	Background 1 min. cou
NA	NA	.1	220
NA	NA	.1	220
NA	NA	.1	220
NA	NA	.1	220
NA	NA	.1	220
Source 1 min. counts	Source 1 min. counts	Source 1 min. counts	Source 1 min. counts
NA	NA	4281	29669
NA	NA	4281	29669
NA	NA	4281	29669
NA	NA	4281	29669
NA	NA	4281	29669
4π % efficiency: 0	4π % efficienc 0	4π % efficiency: 16.71	4π % efficiency: 24.37
2π % efficiency: 0	2π % efficienc 0	2π % efficiency: 34.47	2π % efficiency: 37.5

Alpha Threshold: 120 mV High Voltage: 740 V

Beta Threshold: 3.5 mV Beta Window: 30 mV Next Calibration Due: 5/30/2008

Comments

HV set with probe attached

Performed By: B. French Date: 5/31/07

Reviewed By Mark Vetter Date: 5-31-07

Repair Log

Customer: SAIC

Order Number SAIC20070531-003

Condition Received: fair

Reason for return: recal

Cal. Interval/Special Instructions Received: 1 yr

Instruments 202457

Probe: 212726

Comments

Parts Used

Item:	QTY	Part #	Description	Cost
1				
2				
3				
4				
5				
6				

Calibration Labor Time: 1.25 hrs

Repair Labor Time: 0 hrs

Work Completed By: B. French

Date: 5/31/2007

Person contacted for pickup: b.french

Date: 5/31/2007

Plateau Calibration

Model # 43-89
Serial # 212726
Alpha Source I.D. HB 562
Beta Source I.D. HB 560

Alpha Input Senitivity 120 mV
Beta Input Senitivity 3.5 mV
Beta Window 30 mV
Distance Source to Detector Source Holder

High Voltage	Background Alpha	Background Beta	Source Alpha	Source Beta
500				
525				
550				
575				
600				
625				
650				
675	2	89	3560 / 381	16430 / 1
700	0	145	3847 / 454	21903 / 2
725	0	207	4159 / 731	27021 / 2
750	0	273	4284 / 1310	31210 / 3
775	1	295		
800				
825				
850				
875				
900				
925				
950				
975				
1000				
1025				
1050				
1075				
1100				
1125				
1150				
1175				
1200				
1225				
1250				
1275				
1300				
1325				
1350				
1375				
1400				
1425				
1450				
1475				
1500				

igh Voltage Set 740 V
eviewed By: [illegible] Date: 5-31-07

* Voltage set w/ probe attached

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Gamma Standard

S.O.# 6125
P.O.# N/A

Description of Standard:

Model No. CS-7D Serial No. 5311-04 Isotope Cs-137

The source of gamma radiation is mounted on a 2.54 cm diameter PLASTIC disc, 3 mm thick and sealed in a PLASTIC RESIN.

Measurement Method:

The gamma ray emission rate was compared with a similar standard, which was calibrated by NIST S/N 2752-91. The comparison of relative gama ray emission rates was accomplished using a high resolution gamma-ray detector (nominal active volume 100 cm^3) and a multichannel pulse height analyzer.

Measurement Result:

The gamma ray activity of the standard on 9-22-2004 was 1.0 μCi.

The uncertainty of the measurement is 5 %, which is the sum of the uncertainty assigned to the NIST reference (2.2 %), random counting error at the 99% confidence level, and the estimated upper limit of systematic errors.

Calibrated by: ART REUST Reviewed by: Deborah A. Garcia

Calibration Technician: Art Reust Q.A. Representative: Anthony W. Toth

Calibration Date: 9-22-2004 Reviewed Date: 9-27-04

Analytical Services
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 345-3461 Fax (505) 761-5416
Toll Free (866) RAD-LABS (723-5227)
www.eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Beta Standard

S.O.# 6125
P.O.# N/A

Description of Standard:

Model No. DNS-2sp Serial No. 5313-04 Isotope SrY-90

Electroplated on polished NI disc, 0.79 mm thick.

Total diameter of 2.23 cm and an active diameter of 1.91 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi beta emission rate was measured using an internal gas flow proportional chamber. Absolute counting of beta particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated beta source S/N 4002-02.

Measurement Result:

The observed beta count rate from the surface of the disc per minute (cpm) on the calibration date was:

5,520 ± 165

The total disintegration rate (dpm) assuming 40 % backscatter of beta particles from the surface of the disc, was:

7,900 ± 236 (0.00356 μCi)

The uncertainty of the measurement is 3 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by: Deborah N. Garcia

Calibration Technician: Art Reust Q.A. Representative: Anthony W. Toth

Calibration Date: 9-13-2004 Reviewed Date: 9-27-04

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EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O.# 6125
P.O.# N/A

Description of Standard:

Model No. DNS-4 Serial No. 5312-04 Isotope Th-230

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 2.23 cm and an active diameter of 1.91 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated alpha source S/N 4001-02.

Measurement Result:

The observed alpha particles emitted from the surface of the disc per minute (cpm) on the calibration date was:

9,340 ± 280

The total disintegration rate (dpm) assuming 1.5% backscatter of alpha particles from the surface of the disc, was:

18,400 ± 551 (0.00829 μCi)

The uncertainty of the measurement is 3 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by: Deborah A. Barcia

Calibration Technician: Art Reust Q.A. Representative: Anthony W. Toth

Calibration Date: 9-21-2004 Reviewed Date: 9-27-04

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APPENDIX D

HISTORICAL DOCUMENTATION

(provided electronically)